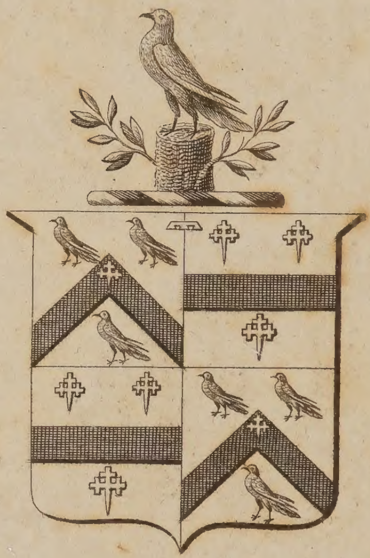

N. Hadley Jun^r.

John Marmaduke Teesdale.

Barr's Buffon.

Buffon's Natural History,

CONTAINING

A THEORY OF THE EARTH,

A GENERAL

HISTORY OF MAN,

OF THE BRUTE CREATION, AND OF VEGETABLES, MINERALS,

&c. &c.

FROM THE FRENCH.

WITH NOTES BY THE TRANSLATOR.

IN TEN VOLUMES.

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CONTENTS

OF

THE THIRD VOLUME.

Directions for placing the Plates.

Page 88, Fig. 1, 2, 3, 4, 5, 6.
106, Fig. 7, 8, 9, 10, 11, 12.
140, Plate III.
148, Plate IV.

BUFFON'S

NATURAL HISTORY.

HISTORY OF ANIMALS.

ARISTOTLE admits, with Plato, of final and efficient causes. These efficient causes are sensitive and vegetative souls, that give form to matter which, of itself, is only a capacity of receiving forms; and as in generation the female gives the most abundant matter, and it being against his system of final causes to admit that what one could effect should be performed by many, he concludes,

that the female alone contains the necessary matter to generation; and, as another of his principles was, that matter itself is unformed, and that form is a distinct being from matter, he affirmed that the male furnished the form, and, consequently, nothing belonging to matter.

Descartes, on the contrary, who admitted but a few mechanical principles in his philosophy, endeavoured to explain the formation of the fœtus by them, and thought it in his power to comprehend, and make others understand, how an organized and living being could be made by the laws of motion alone. His admitted principles differed from those used by Aristotle; but both, instead of examining the thing itself, without prepossession and prejudice, have only considered it in the point of view relative to their systems of philosophy, which could not be attended with a successful application to the nature of generation, because it depends, as we have shewn, on quite different principles. Descartes differs still more from Aristotle, by admitting of the mixture of the seminal liquor of the two sexes; he thinks both furnish something material for generation, and that the fermentation occasioned

soned by the mixture of these two seminal liquors causes the formation of the fœtus.

Hippocrates, who lived under Perdicas, a considerable time before Aristotle, established an opinion, which was adopted by Galen, and a great number of physicians who followed him; his opinion was, that the male and female had each a prolific fluid, and supposed, besides, that there were two seminal fluids in each sex, the one strong and active, the other weak and inactive.* That a mixture of the two strongest fluids produce a male child, and of the two weakest a female; so that, according to him, they each contain a male and a female seed. He supports this hypothesis by the following circumstance; that many women, who produce only girls by their first husbands, have produced boys by a second; and that men, who have had only girls by their first wives, have had boys by others. It appears to me, that if even this circumstance could be well established, it would not be necessary to give to the male and female two kinds of seminal liquor for an explanation, because it may easily be conceived, that women,

 who

* See Hippocrates, lib. de Genitura, page 129, & lib. de diæta, page 198, Lugd. Bat. 1665, vol. I.

who have brought forth only girls by their first husbands, and produced boys with other men, were only those who furnished more particles proper for generation with their first husband than with the second; or that the second husband furnished more particles proper for generation with the second wife than with the first; for when, in the instant of conception, the organic molecules of the male are more abundant than those of the female, the result will be a male, and when those of the female abounds a female will be produced; nor is it in the least surprising that a man should have a disadvantage in this respect with some women, while he will have a superiority over others.

This great physician supposes, that the seed of the male is a secretion of the strongest and most essential parts of all that is humid in the human body; and he thus explains how this secretion is made: "Venæ & nervi, he says, ab omni corpore in pudendum vergunt, quibus dum aliquantulum teruntur & calescunt ac implentur, velut pruritus incidit, ex hoc toti corpori voluptas ac caliditas accidit; quum vero pudendum teritur & homo movetur, humidum in corpore calescit ac diffunditur, & a motu con-

quassatur

quassatur ac spumescit, quem-admodum alii humores omnes conquassati spumescunt.

"Sic autem in homine ab humido spumescente id quod robustissimum est ac pinguissimum secernitur, & ad medullam spinalem venit; tendunt enim in hanc ex omni corpore viæ, & diffundunt ex cerebro in lumbus ac in totum corpus & in medullum; & ex ipsa medull proacedunt viæ, ut & ad ipsum humidum perferatur & ex ipsa secedat; postquam autem ad hanc medullam genitura pervenerit, procedit ad renes, hac enim via tendit per venas, & si renes fuerint exulcerati, aliquando etiam sanguis defertur: a renibus autem transit per medois testes in pudendum, procedit autem non qua urina, erum alia ipsi via eſt illi contigua, &c."*

Anatomists will no doubt discover that Hippocrates is not correct in tracing the road of the seminal liquor; but that does not affect his opinion, that the semen comes from every part of the body, and particularly the head, because, he says, those whose veins have been cut which lie near the ears only bring forth a weak, and very often an unfertile semen. The female has also a seminal fluid, which she emits, sometimes within the matrix, and sometimes without, [illegible] when

* See Fœsius's Translation, vol. I. page 129.

when the internal orifice is more open than it should. The semen of the male enters into the matrix, where it mixes with that of the female; and as each has two kinds of fluid, the one strong and the other weak, if both furnish their strong, a male will be the result, and if their weak, a female; and if in the mixture there are more particles of the male liquor than the female, then the infant will have a greater resemblance to the father than to the mother, and so on the contrary. It might here be asked Hippocrates what would happen when the one furnished its weak semen and the other its strong? I cannot conceive what answer he could make, and that alone is sufficient to cause his opinion of two seeds in each sex to be rejected.

In this manner then, according to him, the formation of the fœtus is made: the seminal fluids first mix in the matrix, where they gradually thicken by the heat of the body of the mother; the mixture receives and attracts the spirit of the heat, and when too warm part of the heat flies out, and the respiration of the mother sends a colder spirit in; thus alternatively a cold and a hot spirit enter the mixture, which give life, and cause a pellicle to grow

on

on the surface, which takes a round form, because the spirits, acting as a centre, extend it equally on all sides. "I have seen, says this great man, a fœtus of six days old; it was a ball of liquor surrounded with a pellicle; the liquor was reddish, and the pellicle was spread over with vessels, some red and others white, in the midst of which was a small eminence, which I thought to be the umbilical vessels, by which the fœtus receives nourishment and the spirit of respiration from the mother. By degrees another pellicle is formed, which surrounds the first; the menstrual blood, being suppressed, abundantly supplies it with nutriment, and which coagulates by degrees, and becomes flesh; this flesh articulates itself in proportion as it grows, and receives its form from the spirit; each part proceeds to take its proper place; the solid particles go to their respective situations and the fluid to theirs: each matter seeks for that which is most like itself, and the fœtus is at length entirely formed by these causes and these means."

This system is less obscure and more reasonable than that of Aristotle, because Hippocrates endeavours to explain every matter by particular reasons: he borrows from the philosophy

losophy of his times but one single principle, which is, that heat and cold produce spirits, and that those spirits have the power of ordering and arranging matter. He has viewed generation more like a physician than a philosopher, while Aristotle has explained it more like a metaphysician than a naturalist; which makes the defects of Hippocrates's system particular and less apparent, while those of Aristotle's are general and evident.

These two great men have each had their followers; almost all the scholastic philosophers, by adopting Aristotle's philosophy, received his system of generation, while almost every physician followed the opinion of Hippocrates; and seventeen or eighteen centuries passed without any thing new being said on the subject. At last, at the restoration of literature, some anatomists turned their eyes on generation, and Fabricius Aquapendente was the first who made experiments and observations on the impregnation and growth of the eggs of a fowl. The following is the substance of his observations.

He distinguished two parts in the matrix of a hen, the one superior and the other inferior. The superior he calls the Ovarium, which

which is properly no other than a cluster of small yellow eggs of a round form, varying in size from the bigness of a mustard-seed to that of a large nut or medlar. These small eggs are fastened together by one common pellicle, and form a body which nearly resembles a bunch of grapes. The smallest of these eggs are white, and they take another colour in proportion as they increase.

Having examined these eggs immediately after the communication of the cock, he did not perceive any remarkable difference, nor any of the male semen in any one of these eggs; he therefore supposed that every egg, and the ovarium itself, became fruitful by a subtle spirit, which came from the semen of the male; and he says, that in order to secure this fecundating spirit, nature has placed at the external orifice of the vagina of birds a kind of net-work or membrane, which permits, like a valve, the entrance of this seminal spirit, but at the same time prevents it from re-issuing or evaporating.

When the egg is loosened from the common pellicle, it descends by degrees through a winding passage into the internal part of the matrix. This passage is filled with a liquor

 nearly

nearly similar to the white of an egg; it is also in this part that the eggs begin to be surrounded with this white liquor, with the membrane which occasions it, the two ligaments (*chalazæ*) which passes over the white, and connects it with the yolk and shell, which are formed in a very short time before they are laid. These ligaments, according to Fabricius, is the part of the egg fecundated by the seminal spirit of the male; and it is here where the fœtus first begins to form. The egg is not only the true matrix, that is to say, the place of the formation of the chick, but it is from the egg all generation depends. The egg produces it as the agent: it supplies both the matter and the organs; the ligaments are the substance of formation; the white and the yolk are the nutriment, and the seminal spirit of the male is the efficient cause. This spirit communicates to the ligaments at first an alterative faculty, afterwards a formative, and lastly the power of augmentation, &c.

These observations of Fabricius have not given us a very clear explication of generation. Nearly at the same time as this anatomist was employed in these researches, towards the middle of the sixteenth century, the famous Aldrovandus

Aldrovandus* also made observations on eggs; but as Harvey judiciously observes, he followed Aristotle much closer than experiment. The descriptions he gives of the chicken in the egg are not exact. Volcher Coiter, one of his scholars, succeeded much better in his enquiries; and Parisanus, a physician of Venice, having also laboured on this subject, they have each given a description of the chicken in the egg, which Harvey prefers to any other.

This famous anatomist, to whom we are indebted for the discovery of the circulation of the blood, has composed a very extensive treatise on generation; he lived towards the middle of the last century, and was physician to Charles I. of England. As he was obliged to follow this unfortunate prince in his misfortunes, he lost what he had written on the generation of insects among other papers, and he composed what he has left us on the generation of birds and quadrupeds from his memory. I shall concisely relate his observations, his experiments, and his system.

Harvey asserts that man and every animal proceed from an egg; that the first produce of conception in viviparous animals is a kind of

 an

* See his Ornithology.

an egg, and that the only difference between viviparous and oviparous is, that the fœtus of the first take their origin, acquire their growth, and arrive at their entire expansion in the matrix; whereas the fœtus of oviparous animals begins to exist in the body of the mother, where they are merely as eggs, and it is only after they have quitted the body of the mother that they really become fœtuses; and we must remark, says he, that in oviparous animals, some hold their eggs within themselves till they are perfect, as birds, serpents and oviparous quadrupeds; others lay their eggs before they are perfect, as fish, crustaceous, and testaceous animals. The eggs which these animals deposit are only the rudiments of real eggs, they afterwards acquire bulk and membranes, and attract nourishment from the matter which surrounds them. It is the same, adds he, with insects, for example, and caterpillars, which only seem imperfect eggs, which seek their nutriment, and at the end of a certain time arrive to the state of chrysalis, which is a perfect egg. There is another difference in oviparous animals: for fowls and other birds have eggs of different sizes, whereas fish, frogs, &c. lay them before they are perfect,

fect, have them all of the same size ; he indeed observes, that in pigeons, who only lay two eggs, all the small eggs which remain in the ovarium are of the same size, and it is only the foremost two which are bigger than the rest. It is the same, he says, in cartilaginous fish, as in the thornback, who have only two eggs which increase and come to maturity, while those which remain in the ovarium are, like those in fowls, of different sizes.

He afterwards makes us an anatomical exposition of the parts necessary to generation, and observes, that in all birds the situation of the anus and vulra are contrary to the situation of those parts in other animals; the anus being placed before and the vulra behind ;* and with respect to the cock, and all small birds, that they generate by external friction, having in fact no intermission nor real copulation ; with male ducks, geese, and ostriches, it is evidently otherwise.

Hens produce eggs without the cock, but in a very small number, and these eggs, although perfect, are unfruitful: he does not agree with the opinion of country people, that two or three days cohabitation with the cock is

* Most of these articles are taken from Aristotle.

is sufficient to impregnate all the eggs a hen will lay within the year, but admits that he separated a hen from a cock for the space of twenty days, and that all the eggs she laid during that space were fecundated. While the egg is fastened to the ovarium, it derives its nutriment from the vessel of the common pellicle. But as soon as it is loosened from it, it derives the white liquor which fills the passages in which it descends, and the whole, even to the shell, is formed by this mode.

The two ligaments *(chalazæ)* which Aquapendente looks on as the shoot produced by the seed of the male, are found in the infecund eggs which the hen produces without the communication with the cock, as in those which are impregnated: and Harvey very judiciously remarks, that those parts do not proceed from the male, and are not those which are fecundated; the fecundated part of an egg is a very small white circle which is on the membrane that covers the yolk, and forms there a small spot, like a cicatrice, about the size of a lentil. Harvey also remarks, that this little cicatrice is found in every fecund or infecund egg, and that those who think it is produced by the seed of the male are deceived. It is of the same

size

size and form in fresh eggs, as in those which have been kept a long time; but when we would hatch them, and when the egg receives a sufficient degree of heat, either by the hen, or artificially, we presently see this small spot increase and dilate nearly like the sight of the eye. This is the first change, and is visible at the end of a few hours incubation.

When the egg has undergone a proper warmth for twenty-four hours, the yolk, which was before in the centre of the shell, approaches nearer to the cavity at the broad end; this cavity is increased by the evaporation of the watery part of the white, and the grosser part sinks to the small end. The cicatrice, or speck, on the membrane of the yolk, rises with it to the broad end, and seems to adhere to the membrane there: this speck is then about the bigness of a small pea, in the middle of it a white speck is discernible, and many circles, of which this point seems to form the centre.

At the end of the second day these circles are larger and more visible; the streak also appears divided by these circles into two, and sometimes three parts of different colours; a small protuberance also appears on the external

part,

part, and nearly resembles a small eye, in the pupil of which there is a point, or little cataract; between these circles a clear liquor is contained by a very delicate membrane, and the speck now appears more to be placed in the white than on the membrane of the yolk. On the third day the transparent liquor is considerably increased, as is also the small membrane which surrounds it. The fourth day, a small streak of purple-coloured blood is observed at the circumference of the speck or ball, at a little distance from the centre of which a point may be seen of a blood colour, and which beats like a heart. It appears like a small spark at each diastole, and disappears at each systole; from this animated speck issue two small blood vessels, which these small vessels throw out as branches into this liquor, all of which come from the same point, nearly in like manner as the roots of a tree shoot from the trunk.

Towards the end of the fourth day, or at the beginning of the fifth, the animated speck is so much encreased as to appear like a small bladder filled with blood, and by its contractions and dilations is alternatively filled and emptied. In the same day this vessel very distinctly appears

to

to divide into two parts, each of which alternatively impel and dilute the blood in the same manner. Around the shortest sanguinary vessel which we have spoken of a kind of cloud is seen, which, although transparent, renders the sight of this vessel more obscure; this cloud constantly grows thicker and more attached to the root of the blood vessel, and appears like a small globe: this small globe lengthens and divides into three parts, one of which is globular, and larger than the other two; the head and eyes now begin to appear, and at the end of the fifth day, the place for the vertebra is seen in the remainder part of this globe.

The sixth day the head is seen more clearly, the outlines of the eyes now appear, the wings and thighs lengthen, and the liver, lungs, and beak, are distinctly observed; the fœtus now begins to move and extend its head, although it has as yet only the internal viscera; for the thorax, abdomen, and all the external coverings of the fore part of the body are wanting. At the end of this day, or at the beginning of the seventh, the toes appear, the chick opens and moves its beak, and the anterior parts of the body begin to cover the viscera; on the seventh day the chicken is entirely formed,

formed, and from this time until it comes out of the egg, nothing happens but only an expansion of those parts it acquired within these first seven days: at the fourteenth or fifteenth day the feathers appear, and at the twenty-first it breaks the shell with its beak, and procures its enlargement.

These observations of Harvey appear to have been made with the greatest exactness; nevertheless we shall point out how imperfect they are, and that he has fallen himself into the error he reproaches others with, making experiments to support his favourite hypothesis, that the heart was the animated speck which first appeared; but before we proceed on this matter, it is but just to give an account of his other observations, and of his system.

It is well known that Harvey made many experiments on hinds and does. They receive the male towards the middle of September: a few days after copulation the horns of the matrix become thicker, and at the same time more lax. In each of the cavities five caruncluas appear. Towards the 26th or 28th of the above month the matrix thickens still more, and the five caruncluas are swelled nearly to the shape and size of a nurse's nipple; by opening them, an infinity of small white

specks

specks are found. Harvey pretends to have remarked, that there was neither then, nor immediately after copulation, any alteration or change in the ovarium, and that he has never been able to find a single drop of the seed of the male in the matrix, although he has made many researches for that purpose.

Towards the end of October, or beginning of November, when the females separate from the males, the thickness of the horns begins to diminish, the internal surfaces of their cavities are swelled, and appear fastened together; the caruncülas remain, and the whole, which resembles the substance of the brain, is so soft that it cannot be touched. Towards the 13th or 14th of November, Harvey says, that he perceived filaments, like the threads of a spider's web, which traversed the cavities of the horns and the matrix itself: these filaments shoot out from the superior angle of the matrix, and by their multiplication form a kind of membrane, or empty tunic; a day or two after this tunic is filled with a white, aqueous and glutinous matter, which adheres to the matrix by a kind of mucilage; and in the third month this tunic, or pouch, contains an embryo about the breadth of two fingers long, and another internal pouch, called the amnios, containing

a transparent crystalline liquor, in which the fœtus swims. The fœtus at first was but an animated speck, like that in the egg of a fowl. All the rest is performed in the same manner as that related of the chick; the only difference is in the eyes, which appears much sooner in the fowl than in the deer. The animated speck appears about the 19th or 20th of November, a day or two after which the oblong body, which contains the fœtus, is seen; in six or seven days more it is so much formed that the sex and limbs may be distinguished; but the heart and viscera are yet uncovered, and it is two days more before the thorax and the abdomen cover them, which is the last work and completion of the edifice.

From these observations upon hens and deer, Harvey concludes, that all female animals have eggs, that in these eggs a separation of a transparent crystalline liquor contained in the amnios is made, and that another external pouch, the chorion, contains the whole liquors of the egg; that the first thing which appears in the crystalline liquor is the sanguinary and animated spirit; in a word, that the formation of viviparous animals is made after the same manner as oviparous; and he explains the generation of both as follows.

Generation

Generation is the work of the matrix, in which no seed of the male ever enters; the matrix conceives by a kind of contagion, which the male liquor communicates to it, nearly as the magnet communicates its magnetic virtue to steel. This male contagion not only acts upon the matrix but over all the female body, which is wholly fecundated, although the matrix only has the faculty of conception, as the brain has the sole faculty of conceiving ideas. The ideas conceived by the brain, are like the images of the objects transmitted by the senses; and the fœtus, which may be considered as the idea of the matrix, is like that which produces it. This is the reason that a child has a resemblance to its father, &c.

I shall not follow this anatomist any farther; what I have mentioned is sufficient to judge of his system; but we have some remarks to make on his observations. He has given them in a manner most likely to impose; seems to have often repeated his experiments, and to have taken every necessary precaution to avoid deception; from which it might be imagined he had seen all he writes upon, and observed them with he greatest accuracy. Nevertheless, I perceive both uncertainty and obscurity

scurity in his descriptions; his observations are related chiefly on memory; and although he often says the contrary, Aristotle appears to have been his guide more than experience; for he has only seen in eggs what Aristotle has before mentioned; and that most of his observations which may be deemed essential had been made before him, we shall be perfectly convinced if we pay a little attention to what follows:

Aristotle knew that the ligaments (Chalazæ) were of no service to the generation of the chicken. "Quæ ad principium lutei grandines hærent, nil conferunt ad generationem, ut quidam suspicantur."* Parisanus, Volcher, Coiter, Aquapendente, and others, remarked the cicatrice as well as Harvey: Aquapendente supposed it of no use; but Parisanus pretended that it was formed by the male semen, or at least that the white speck in the middle of the cicatrice was the seed of the male which would produce the chicken. "Est-que, says he, illud galli semen alba & tenuissima tunica abductum, quod substat duabus communibus toti ovo membranis, &c." Therefore the only discovery which properly belongs

* Hist. Anim. lib. vi. cap. 2.

longs to Harvey is, his having observed that this cicatrice is found in infecund as well as fecundated eggs; for others had observed, like him, the dilation of the circles, and the growth of the white speck; and it appears that Parisanus had seen it much better; this is all which he remarks in the two first days of incubation; and what he says of the third day, is only a repetition of Aristotle's words. * "Per id tempus ascendit jam vetellus ad superiorem partem ovi acutiorem, ubi & principium ovi est & fœtus excluditur; corque ipsum apparet, in albumine sanguinei puncti, quod punctum salit & movet sese instar quasi animatum; ab eo meatus venarum specie duo, sanguinei pleni, flexuosi, qui, crescente fœtu, feruntur in utramque tunicam ambientem, ac membrana sanguineas fibras habens eo tempore albumen continet sub meatibus illis venarum similibus; ac paulo post discernitur corpus pufillum initio, ommino & candidum, capite conspicuo, atque in eo oculis maxime turgidis qui diu sic permanent, sero enim parvi fiunt ac considunt. In parte autem corporis inferiore, nullum extat membrum per initia, quod respondeat superioribus. Meatus autum illi qui a corde prodeunt,

* Hist. Anim. lib. vi. cap. 4.

deunt, alter ad circumdantem, membranam tendit, alter ad luteum, officio umbilici."

Harvey attacks Aristotle for saying that the yolk ascends towards the small end of the egg, and concludes, that he had not seen any thing himself, but had apparently received his information from some good observer of Nature. Harvey was wrong in thus reproaching Aristotle, and in asserting that the yolk always ascends towards the broad end of the egg, for that depends on the position of the egg during the time of incubation, for the yolk always ascends to the uppermost part, as being lighter than the white, whether it be to the broad or the small end. William Langley, a physician at Dordrecht, who made observations on the hatching of eggs, in 1655, twenty years before Harvey, was the first who made this remark.*

But to return to the passage we have quoted. By that we see that the crystalline liquor, the animated speck, the two circles, the two blood vessels, &c. are described by Aristotle precisely as Harvey had seen them. This anatomist also pretends that the animated speck is the heart, that this heart is formed the first, and that

* See Wm. Langley Observ. edæ a justo Schradero, Amst. 1674.

that the viscera and other parts are joined afterwards. All this has been spoken of by Aristotle, and seen by Harvey, and nevertheless it is not conformable to truth. To be assured of this we need only repeat the same experiments on eggs, or only read with attention those of Malpighius,* which were made about 40 years after those of Harvey.

This excellent observer of Nature examined, with attention, the cicatrice, which is the essential part of the egg; he found it was large in all impregnated eggs, and small in those which were not impregnated; and he discovered in eggs which had never been sat upon, that the white speck, spoken of by Harvey as the first which becomes animated, is a small pouch or ball, which swims in a liquor inclosed by the first circle, and in the middle of this ball he observed the embryo. The membrane of this small pouch, which is the amnios, being very thin and transparent, permitted him easily to see the fœtus it surrounded. Malpighius, with reason, concludes, from this first observation, that the fœtus exists in the egg before incubation, and that its first outlines are then very strong. It is not necessary to point out how opposite this experiment

* Malpighii pullus in ovo.

ment is to the opinion of Harvey, for he saw nothing of a form for the two first days of incubation, and it was the third day before the sign of the fœtus appears, which is the animated speck: whereas according to Malpighius, the outlines of the fœtus exist in the egg before incubation has commenced.

After being assured of this important matter, Malpighius examined, with like attention, the cicatrice of unimpregnated eggs, which, as we have observed, is smaller than those which have been impregnated; it has often irregular circumscriptions, and sometimes differs in different eggs. Near its centre, instead of the ball that encloses the fœtus, there is a globular mole, which does not contain any thing organized, and which being opened does not present any thing formed or arranged, but only some appendages filled with a thick but transparent fluid; and this unshapen mass is surrounded with many concentric circles.

After six hours incubation the cicatrice is considerably dilated, and the ball formed by the amnios is easily discovered; this ball is filled with a liquor, in the middle of which the head of the chicken and back-bone are distinctly seen. In about six hours more the little animal

mal is seen more distinctly; in another six hours the head is grown larger, and the spine lengthened; and at the end of twenty-four hours the neck begins to lengthen, the vertebræ of the back appears of a white colour, and the head to turn to one side. The vertebræ are disposed on each side of the spine, like small globules; and almost at the same time the small wings begin to shoot, and the head, neck, and breast are lengthened. After thirty hours nothing new appears, but every part of the little animal is considerably increased, especially the *amnios*. Around this membrane the umbilical vessels are seen of a darkish colour. At the end of thirty-eight hours, the chicken being grown much larger, its head is large, and in which are distinguished three vessels surrounded with membranes, which also cover the back bone, through which the vertebræ are still seen. In forty hours, continues Malpighius, it was wonderful to see the chicken alive, floating in the liquor; the back bone was encreased, the head was turned on one side, the vesicles of the brain were less apparent, the first outlines of the eyes appeared, the heart beat, and the circulation of the blood was begun. Malpighius then

gives the description of the vessels and course of the blood, and reasonably supposes that, though the heart does not beat before thirty-eight or forty hours incubation, it still existed before that time, like the other parts of the chicken; but on examining the heart in a dark room, he discovered not the least glimpse of light to proceed from it, as Harvey insinuates.

At the end of two days the chicken is seen floating in the liquor of the amnios; in which the head, composed of vesicles, is turned on one side; the back bone and vertebræ are lengthened; the heart, which then hung out of the breast, beat three times; for the fluid it contains is impelled into the ventricles of the heart, from thence into the arteries, and afterwards into the umbilical vessels. He remarks, that having separated the chick from the white of the egg, the motion of the heart still continued for a whole day. After two days and fourteen hours, or sixty-two hours of incubation, the chicken, although grown stronger, remained with its head bent downwards in the liquor, contained by the amnios; the veins and arteries were seen among the vessels of the brain; the lineaments of the

eyes,

eyes, and the spinal marrow, also appear extending the length of the vertebræ.

At the end of the third day the head of the chicken appeared crooked; besides the eyes five vessels were seen in the head filled with a liquid matter; the first outlines of the wings and thighs were to be distinguished, and the body began to gather flesh; the pupil of the eye, and also the crystalline and vitreous humour were discernible. At the fourth day the vesicles of the brain were nearer each other; the eminences of the vertebræ were more prominent, the wings and thighs assumed a greater solidity as they increased in length; the whole body, covered with a jelly-like flesh, was now surrounded within the body by a thin membrane, and the umbilical vessels that unite the animal to the yolk, appeared to come from the abdomen. On the fifth and sixth days the vesicles of the brain began to be covered; the spinal marrow, divided into two parts, began to take solidity and stretch along the trunk; the wings and thighs lengthened; the feet began to spread; the belly was closed up and tumid; the liver was distinctly seen, and appeared of a dusky white; the ventricles of the heart were discerned to beat

very

very distinctly; the body of the chicken was covered with a skin, and the traces of the feathers were visible; the seventh day the head appeared very large, the brain was entirely covered with its membranes; the beak began to appear betwixt the eyes, and the wings, the thighs, and the legs had acquired their perfect figure.

I shall not follow Malpighius any farther, as the remainder relates only to the expansion of the parts till the twenty-first day, when the chicken breaks the shell with its beak; though before that time it is heard to chirrup in its imprisonment. The heart is the last part which receives its proper form, for it is eleven days before the arteries are seen to join, and the ventricles become perfectly conformable and united.

We are now in a condition to judge of the value of Harvey's experiments and observations. There is great appearance this anatomist did not make use of a microscope, which in fact was not brought to perfection in his days, or he would not have asserted there was no difference between the cicatrice of an impregnated and an unimpregnated egg; he would not have said the seed of the male produced

no

no alteration in the egg, especially in the cicatrice; he would not have affirmed that nothing was perceptible till the third day, that the animated speck was the first that appeared, and into which the white speck was changed. He would have seen that the white speck was a ball which contained the whole apparatus of generation, and that every part of the fœtus are there from the moment the hen has connection with the cock. He would also have learnt, that without this connection it contains only an unshapen mass, which could never become animated, because in fact it is not organized like an animal, and because it is only when this mass, which we must look upon as an assemblage of the organic particles of the female semen, is penetrated by the organic particles of the male semen, that there results from it an animal, which is formed at the moment, but whose motion is imperceptible till the end of forty hours after: he would not have asserted that the heart is first formed, and that the other parts are joined to it by a juxtaposition, since it is evident from Malpighius's observations, that the outlines of every part are all immediately formed, but only appear in proportion as they dilate; on the whole, if he

had

had seen what Malpighius saw, he would not have affirmed that no impression of the male seed remained in the eggs, and that it was only by contagion that they are fecundated, &c.

It is also just to remark, that what Harvey has said on the parts of the generation of a cock is not exact; he asserts that the cock has no genital member, and that there is no intromission; nevertheless it is certain that this animal, instead of one has two, and that they both act at the same time, and which action is a very strong compression, if not a true copulation;* and it is by this double organ that the cock emits the seminal liquor into the matrix of the hen.

Let us now compare the experiments made by Harvey on hinds with those of De Graaf on doe rabbits; we shall find that although De Graaf supposes, with Harvey, that all animals proceed from eggs, yet there is a great difference in the mode which these two anatomists have observed in the first steps of formation, or rather expansion, of the fœtuses of viviparous animals.

After having exerted every effort to establish, by reasons drawn from comparative ana- [illegible] tomy,

* See Reyn. Graaf, page 242.

tomy, that the testicles of viviparous females are real ovaries, De Graaf explains how the eggs are loosened from the ovaries and fall into the horns of the matrix; he then relates what he observed in a rabbit, which he dissected half an hour after copulation. The horns of the matrix, he says, were more red than before, but no other change in the rest of the parts: there was also no appearance of any male seed, neither in the vagina, matrix, nor horns of the matrix.

Having dissected another six hours after copulation he observed the follicules, or coats, which he supposes contained the eggs in the ovary, were become red, but found no male seed either in the ovaria or elsewhere. He dissected another twenty-four hours after copulation, and remarked in one ovarium three, and in the other five follicules that were changed, the transparency being become dark and red. In one dissected twenty-seven hours after copulation he perceived the horns of the womb had become more red and strictly embraced the ovaries. In another, that he opened forty hours after copulation, he found in one of the ovaries seven follicules, and in the other three that were changed. Fifty-two hours

after copulation he examined another and found one follicle changed in one of the ovaries and four in another, and having opened these follicules he found a glandular liquor, in the middle of which there was a small cavity, where he did not perceive any liquor, which made him suppose that the transparent liquor, commonly contained in the follicules, and which, he says, is enclosed in its own membranes, might have been separated by a kind of rupture: he searched after this matter in the passages, and in the horns of the matrix themselves, but he found none; he only perceived that the internal membrane of the horns of the matrix was very much swelled. In another, dissected three days after copulation, he observed that the superior extremity of the passage, which communicates with the horns of the matrix, strictly embraced the ovaries; and having separated it he perceived three follicules, longer and harder than usual. After searching with the greatest attention the passages abovementioned he found in the right passage one egg, and in the right horn of the matrix two more, not bigger than a grain of mustard-seed: those little eggs were each closed in double membranes, and the inner one was filled with a very

a very limpid liquor. Having examined the other ovarium he found four follicules that were changed, three of which were white and had a little liquor within them; but the fourth was of a darker colour, and contained no liquor, which made him judge that from this the egg had been separated. Pursuing his enquiries he found an egg in the superior extremity of the other horn, and exactly like those he had discovered in the right one. He says that the eggs which are separated from the ovary are ten times smaller than those which are fastened to it; and he thinks that this difference is occasioned from the eggs containing, when they are in the ovaries, another matter, and that is the glandular liquor he remarked in the molecules.

Four days after copulation he opened another, and found in one of the ovaries four, and in the other three follicules, emptied of their eggs; and in the horns corresponding to these he found an equal number of eggs. These eggs were larger than the first that he found three days after copulation, and were about the size of a small bird-shot; he also remarked that the internal membrane in these eggs was separated from the external, and appeared like

a second egg in the first. In another, dissected five days after copulation, he found five empty follicules in the ovaries, and as many eggs in the matrix, to which they adhered. These eggs were about the size of a duck-shot, and the internal membrane was more apparent than in the one he had observed before. In one which he opened six days after copulation there were six empty follicules in one ovaria, and only five eggs in the corresponding horn, and they appeared in one mass; in the other ovaria were four empty follicules and but one egg; these eggs were as big as swan-shot. He opened another on the seventh day after copulation, and found seven empty follicules; he also perceived several internal tumours in the matrix, from whence he took eggs the size of a pistol-bullet. Its membrane was more distinct than before, but contained only a very clear liquor. In one, eight days after copulation, he found in the matrix tumours, or cells, which contained the eggs, but they were very adherent, for he could not loosen them. In another, nine days after copulation, the cells, which contained the eggs, were greatly increased, and he saw that the liquor inclosed by the internal membrane had now got a light cloud floating upon it.

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He opened another ten days after copulation and the cloud was thicker, and formed an oblong body, like a little worm. At last, on the twelfth day after copulation, the figure of the embryo was distinctly to be perceived, which two days before only presented the figure of an oblong body; it was even so apparent that the different members might be distinguished. In the region of the breast he perceived two red and two white specks, and in the abdomen a mucilaginous substance, somewhat reddish. Fourteen days after copulation the head of the embryo was become large and transparent, the eyes prominent, the mouth open, the rudiments of the ears appeared; the backbone, of a whitish colour, was bent towards the breast, and small blood-vessels came from each side, whose ramifications ran along the back as far as the feet; the two red specks, being considerably increased, appeared to be no other than the ventricles of the heart; by the sides of these red specks were two white ones, which were the rudiments of the lungs. In the abdomen the outlines of the liver were seen of a reddish colour, and a little intricate mass, like a ravelled thread, which was the stomach and intestines. After this the process was no more than a

growth

growth and expansion of every part till the thirty-first day, when the female rabbit brings forth her young.

From these experiments De Graaf concludes, that all viviparous females have eggs; that these eggs are contained in the testicles, called ovaries; that they cannot disengage themselves till they are impregnated, because, he says, the glandular substance, by means of which the eggs quit their follicules, is not produced till after an impregnation. He also insists, that those who suppose they have seen eggs in only two or three days increased in size, must have been mistaken, for these eggs remain a longer time in the ovary, although fecundated, and instead of immediately increasing, they rather diminish until they are descended from the ovaries into the matrix.

By comparing these observations with those of Harvey, we shall easily perceive that the principal circumstances have escaped the latter; and although there are many errors in the reasoning and experiments of De Graaf, nevertheless this anatomist, as well as Malpighius, has made better observations than Harvey. They agree in the principal points, and are both contrary to Harvey; the latter had never

seen the alterations which happen to theovary; he did not see the small globules in the matrix which contain the apparatus of generation, and which De Graaf calls *eggs*. He had not even a supposition that the fœtus existed in this egg; and though his experiments gave us nearly an exact account of what occurs during the growth of the fœtus, they give us no information either of the moment of fecundation or of the first developement. Schrader, a Dutch physician, who held Harvey in great veneration, owns that we must not put too great a reliance in that anatomist in many things, and especially on what he says of the fecundative moment, for the chicken in fact is in the egg before incubation, and that Joseph de Aromatarius was the first who observed it.* Although Harvey pretended that every animal proceeds from an egg, he did not imagine that the testicles of females contained these eggs, and has only repeated what Aristotle has said on this subject. The first who speaks of having discovered eggs in female ovaries is Steno, who says, in dissecting a female sea-dog he saw eggs in the testicles, although that animal is viviparous; and he adds, that the testicles

* See Observ. Justi Schraderi, Amst. 1674.

ticles of women are analogous to the ovaries of oviparous animals, whether the eggs fall in any manner into the matrix, or whether there only falls the matter they contain. Although Steno is the first who discovered these pretended eggs, De Graaf claims the merit to himself, and Swammerdam has disputed it with him, insisting that Van Horn had perceived these eggs before De Graaf. It is true this last writer stands charged with asserting many things experience has found to be false. He pretended that a judgment might be formed of the number of fœtuses contained in the matrix by the number of cicatrices, or empty follicules, in the ovary, which is not true, as we may see by the observations of Verrheyen,* and by those of M. Mery,† and by some of De Graaf's own observations, where he found fewer eggs in the matrix than cicatrices in the ovaries. Besides, we shall make it appear that what he says concerning the separation of the eggs, and the manner in which they descend into the matrix, is not exact; that no eggs exist in the female testicles; that what is seen in the matrix is not an egg; and that nothing

* Vol. I. chap. iii. Brussels edit. 1710.

† Hist of the Academ. 1701.

thing can be worse founded than the systems endeavoured to be established on the observations of this famous anatomist.

This pretended discovery of eggs in the testicles of females attracted the attention of most anatomists; they, however, only met with small bladders in the testicles of female viviparous animals, these they did not hesitate to look on as real eggs: they therefore gave the name of *ovaries* to the testicles, and called the vesicles *eggs*. They also said, with De Graaf, that there are eggs of different sizes in the ovarium; that the largest in the ovarium of women was not above the size of a small pea; that they were very small in the young, but increased with age and intercourse with men; that twenty might be counted in each ovarium; that these eggs are fecundated in the ovarium by the spirited part of the seminal liquor of the male; that afterwards they loosen and fall into the matrix, where the fœtus is formed, from the internal substance of the egg and the placenta of the external matter; that the glandular substance, which does not exist in the ovarium till after a fruitful copulation, serves to compress the egg, and make it quit the ovarium, &c. But Malpighius having

 examined

examined things more minutely, detected many of their errors before they were even received; yet most physicians adopted the sentiments of De Graaf, without any attention to the observations of Malpighius; which, notwithstanding, are very important, and to which his scholar Valisnieri has given a great deal of weight.

Malpighius and Valisnieri, of all naturalists, speak with the greatest foundation on the subject of generation. We shall therefore give an account of their experiments and remarks, to which we cannot pay too much attention.

Malpighius having examined a great number of the testicles of cows and other female animals, affirms that he found vesicles of different sizes in the testicles of all of them, whether young or adults; these vesicles are inclosed by a thick membrane, in the inner parts of which there are blood-vessels, filled with a kind of lymph, or liquor, which hardens by the heat of the fire like the white of an egg.

In time a firm yellow body grows which adheres to the testicles. It is prominent and increases to the size of a cherry, occupying the

the greatest part of the ovarium. The body is composed of many little angular tubes, and its position is irregular; it is covered with a coat, or membrane, spread over with nerves and blood-vessels. The appearance and form of this yellow body are not always the same, but vary according to time. When not above the size of a millet seed, it is nearly globular, and if divided appears composed of a kind of variegated nét-work. Very often an external covering is observed, composed of the same substance as the yellow body, around the vesicles of the ovarium.

When the yellow body is become nearly of the size of a pea, it is the shape of a pear, in which is a small cavity filled with liquor; as is also the case when grown to the size of a cherry. In some of these yellow substances, when increased to their full maturity, Malpighius says, a small egg, with its appendages, not bigger than a millet seed, may be seen near the centre; when they have cast out their eggs they are empty, resemble a cavernous passage, and the cavities which inclose them are about the size of peas. He thinks this yellow and glandular substance nature produces to preserve the egg, and assist it in leav-

ing the testicles, and perhaps to contribute towards the generation of the egg itself; consequently, he says, the vesicles, which are always observed in the ovary, and which are of different sizes, are not real eggs that may be fecundated, but only serve for the production of the yellow body where the egg is to be formed. On the whole, although these yellow substances are not found at all times in all testicles, we nevertheless always find the first traces of them, and Malpighius having seen the marks of them in young heifers, cows that were with calf, and in pregnant women, he reasonably concludes that this yellow and glandular substance is not, as De Graaf has supposed, the effect of fecundation, but what produces the infecund eggs, which leave the ovary without any communication with the male, as well as to those which leave it after communication. When the latter falls into the tubes of the matrix, all the rest is performed as De Graaf has described.

These observations of Malpighius shew that the testicles of females are not real ovaries, as most anatomists believe; that the vesicles they contain are not eggs; that these vesicles never fall into the matrix; and that

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the testicles, like those of the male, are kinds of reservoirs, containing a liquor which must be looked upon as an imperfect seed of the female, that is perfected in the yellow glandular body which fills the internal cavity, and is shed when the glandular substance has acquired its full maturity. But before we decide on this important point, we must relate the observations of Valisnieri; and we shall perceive that, though Malpighius and Valisnieri have made good observations, they have not carried them far enough, nor drawn those consequences from them which their observations might naturally have produced, because they were both prejudiced for the system of eggs, and of the fœtus pre-existing therein.

Valisnieri began his experiments in 1692, on the testicles of a sow, whose testicles are not composed like those of a cow, sheep, mare, bitch, female ass, she goat, nor most other viviparous females, for they resemble a small bunch of grapes, whose seeds are round and prominent outwardly. Between these seeds there are smaller, which have not arrived to maturity. These seeds do not appear to be surrounded with one common membrane; they are, he says, similar to those yellow sub-

stances

stances which Malpighius observed in cows; they are round, of a reddish colour, their surface sprinkled over with sanguinary vessels like the eggs of viviparous animals, and together form a mass larger than the ovary; we may, with a little address, and by dividing the membrane, separate these grains one by one, and draw them from the ovary, where they each leave an impression.

These glandular substances are not of the same colour in every sow, in some they are red, in others more clear; and they are of all sizes, from the most minute point to that of a grape. On opening them we find a triangular cavity filled with a limpid liquor, which coagulates by the fire, and becomes white like that contained in the vesicles. Valisnieri hoped to meet with the egg in one of those cavities, but although he sought for it with the utmost assiduity in the glandular substance of the ovaries of four different sows, and afterwards in those of other animals, yet he could never discover the egg which Malpighius asserts to have met with once or twice.

Below these glandular substances the vesicles of the ovary were seen, and which were in a greater or lesser number as the glandular substances

stances are thicker or smaller, for in proportion as the glandular substances increase, the vesicles diminish. Some of these vesicles were the size of a lentil, and others as small as a millet-seed. In crude testicles twenty, thirty, or thirty-five vesicles might be counted, but when boiled a greater number are seen; and they are so strongly connected by fibres and membraneous vessels, that it is impossible to separate them without a rupture.

Having examined the testicles of a sow which never had littered, he found there, as in the rest, glandular bodies, and their triangular cavities filled with lymph, but never met with the egg either in the one or the other. The vesicles of this sow which had never littered were greater in number than in those which had littered or conceived. In the testicles of another sow which had conceived, and whose young were much expanded, he found two large glandular substances, that were empty, and others smaller, in their common state. Having also dissected many others when with young, he found that the number of glandular substances was always greater than that of the fœtus, which confirms our observations on De Graaf's experiments, and proves they are

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not exact; what he terms the follicules of the ovary being only the glandular substances, whose number always exceed that of the fœtus. In the ovaries of a sow but a few months old, the testicles were large, and sprinkled with vesicles pretty well tumefied: between these vesicles there were four rising glandular substances in one of the testicles, and more in the other.

After having finished his experiments on sows, Valisnieri repeated those of Malpighius on the testicles of cows, and found that all he had said was conformable to truth; only Valisnieri owns that he has never been able to find the egg which Malpighius thought he had seen once or twice in the internal cavity of glandular bodies. Valisnieri proceeded in his experiments upon a variety of other animals to discover this egg, but in vain; nevertheless his prejudice for that system induced him, contrary to his experience, to admit the existence of eggs, which neither he nor any other man ever did or ever will see. It is scarcely possible to make a greater number of experiments, or better than he has done. He observes, as something particular to a ewe, that there are never more glandular substances in the testicles than fœtuses

fœtuses in the matrix. In young ewes, which have never been with the male, there is but one glandular substance in each testicle, which when worn away, another is found; and if a ewe has only one fœtus in her matrix, there is but one glandular substance in the testicles; if there are two fœtuses there will be two glandular substances. This substance occupies the greatest part of the testicles; after it disappears another is formed for the purpose of another generation.

In the testicles of a she-ass he perceived vesicles the size of small cherries, which evidently prove they are not eggs, since, being of that size, they could not enter into the horns of the matrix, which are too narrow in this animal for their reception.

The testicles of a female dog, wolf, or fox, have a kind of cowl, or covering, which is produced by the expansion of the membrane that surrounds the horns of the matrix. In a bitch, whose heat was just began, and had not been brought to a dog, Valisnieri found this cowl, which is not adherent to the testicle, internally bathed with a liquor like whey: he discovered also two glandular substances in the right testicle, which run almost its whole length. These

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glandular substances had each a small nipple, with a little orifice, from which of itself issued a clear liquor like whey, and when pressed, a greater quantity came out, which made him imagine, that this liquor was the same as that found within the cowl: he blew into this orifice, by the means of a small pipe, and immediately the glandular body was puffed up; and having introduced a bristle, he easily penetrated to the end of it: he opened this glandular substance the same way as the bristle was entered, and found within a cavity which communicated with the orifice, and which also contained a good deal of liquor. Valisnieri was also in hopes to discover the egg, but, notwithstanding all his endeavours and strict attention, he never could perceive it. He remarked, that the extremity of these nipples, from which this liquor flowed, was contracted by a sphincter, which served to shut up, or open the orifice of the nipple: he found also in the left testicle two glandular bodies with the like cavities, nipples, orifices, and liquor distilling from them. Still not being able to find the egg, neither in this liquor, nor in the cavity which contained it, he boiled two of these glandular substances, hoping that by this means he might discover the object

ject he was in pursuit of, but it was all in vain.

Having opened another bitch, eight or nine days after she had been with the male, he found no difference in the testicles; there were three glandular substances like the preceding ones, and, like them, distilled a liquor from the nipples. Here he also persevered in his fruitless researches after the egg. By the help of a microscope, he perceived the glandular substances were a kind of vascular net-work, formed by an infinite number of small globular vesicles which served to filtre the liquor that issues through the end of the nipple.

After this he opened another bitch whose heat was off, and having introduced air between the testicle and its covering, he found it dilated like a bladder by means of inflation; having raised this cowl, he found three glandular substances on the testicle, but they had no apparent nipple, nor orifice, nor did any liquor distil from them.

In another bitch that had pupped two months, and had five puppies, he found five glandular substances, which were become very small, and began to obliterate, without leaving any cica-

 trices;

trices: there still remained a small cavity in the middle, but it was dry and empty.

Not content with these, and many more experiments, Valisnieri, who would not give up his researches after the pretended egg, called together the most expert anatomists of his country, among whom was M. Morgagni, and having opened a young bitch at the time of her first heat, and had been with a male three days before, they examined the vesicles of the testicles, the glandular substances with their nipples, orifice, and liquor which flowed from them, and in their internal cavities, but not an egg was to be found. After this he made experiments on female goats, foxes, cats, and a great number of mice, &c. He always found vesicles in the testicles of all those animals, and often the glandular substances, and the liquor they contained, but never any egg.

At length, desirous of examining the testicles of a woman, he had an opportunity of opening a farmer's wife, a young woman that was killed by a fall from a tree. She had been married several years, but although of a good habit of body, yet she had never borne a child. He sought if the cause of her sterility was not discoverable

discoverable in the testicles; and he found the vesicles all replete with a blackish and corrupted matter.

In the testicles of a girl of eighteen, who had been brought up in a convent, and, according to all appearances, was a virgin, he found the right testicle somewhat larger than the left: its shape was oval, and its surface a little unequal. This inequality was produced by the protuberance of five or six vesicles of this testicle which advanced forwards; one of which was more prominent than any of the rest. Having opened this vesicle, a spirit of lymph issued out: around it there was a glandular substance in form of a crescent of a yellowish colour rather bordering on the red. He cut the remainder part of the testicle transversely, and found many vesicles filled with a limpid liquor, and remarked that the corresponding trunk to this testicle was very red and a little longer than the other, as he had frequently observed in female animals, when in their amorous season.

The left testicle was as round as the right, it was whiter, and its surface more smooth; for although there were some vesicles a little prominent, yet there were not any in form of a nipple; they were all alike, without any glandular substance,

substance, and the corresponding trunk was neither inflamed nor red.

In a little girl of five years old, he found the testicles with the vesicles, blood vessels, fibres and nerves complete.

In the testicles of a woman sixty years of age, he found some vesicles, and the vestiges of a glandular substance, which were as so many thick points of matter of a dark brownish colour.

From all these observations Valisnieri concludes, that the business of generation is carried on in the female testicles, which he looked upon as ovaries, although he never found any eggs in them, but on the contrary, evidently saw that the vesicles were not eggs. He also says, that it is not necessary for the seed of the male to enter into the matrix to impregnate the egg: he supposes that the egg comes from the nipple of the glandular substance, after impregnation in the ovarium; that from thence it falls into the trunk, and descends by degrees, till at last it fastens to the matrix. He adds, he is persuaded that the egg is concealed in the glandular substance, and that all the business of generation is performed in the cavity, although neither he

nor

nor any other anatomist, have ever seen or been able to find it.

According to Valisnieri the spirit of the male seed ascends to the ovarium, forces its way into the egg, and gives motion to the fœtus that pre-exists therein. In the ovarium of the first woman were eggs, which not only inclosed in miniature every child she brought forth, but of the whole human-race. That if we cannot conceive this infinite chain of individuals contained in one, it is the fault of our minds, the weakness of which is every day perceptible; but it is, upon that account, no less true, that every animal which has been, is, and will be, were created all at one time, and inclosed in the first females. The resemblance of children to parents only proceeds, continues he, from the imagination of the mother, the power of which is so great on the fœtus that it can produce on it spots, marks, disproportions, and extraordinary births, as well as perfect resemblances.

This system of the eggs, which is unreasonable, and without foundation, would, nevertheless, have obtained the unanimous suffrages of all physicians, if, when it was first endeavoured to be established, another system had

not been formed on the discovery of spermatic animals.

This discovery, for which we are indebted to Leeuwenhoeck and Hartsoeker, has been confirmed by Andri, Valisnieri, Bourguet, and many other observers of Nature. I shall relate what has been said concerning the spermatic animals which are found in the seminal liquor of all males: they are in such vast numbers that the semen seems to be entirely composed of them; and Leeuwenhoeck pretends to have seen many millions of them in a drop smaller than the smallest grain of sand. Although we do not meet with any in female animals they abound in all males, both in the semen emitted naturally and that in the testicles, as well as in the seminal vesicles. If the semen of a man is exposed to a moderate heat it thickens, and the motions of all the animalcules immediately cease, but if allowed to cool it becomes thinner, and the animals preserve their motion till the liquor thickens as it dries away. The thinner the liquor becomes the more the animalcule increase, and if water is added it will appear like a substance of small animals. When the motion of these animalcule is nearly finished, whether from heat, or

any

any other cause, they seem to assemble closer together, and have a whirling motion in the centre of a small drop which may have been taken out for observation, and appear all to perish at one and the same time, whereas in the larger portion of the liquor they are easily seen to perish successively.

The animalculæ, say they, have different figures in different animals; nevertheless they are all long, slender, without any appearance of limbs, and move with rapidity. The fluid which contains them, as we have already observed, is heavier than blood. The semen of a bull afforded Verrheyen, by a chemical process, first phlegm, afterwards a considerable quantity of fœtid oil, but little volatile salt, and much more earth than he could have thought.* This author appears surprised that in rectifying the distilled liquor he could not draw any spirit from it, and being persuaded it contained a great quantity, he attributed the evaporation to its great subtility: but may it not be more reasonably imagined that it contains very little or no spirits, as neither its consistency nor smell announce any ardent spirit, and which is only plentifully found in fermented liquors? besides,

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* See Veerheyen, sup. anat. tom. ii. page 69.

with respect to volatile spirits, the horns, bones, and other solid parts of animals, afford more than all the liquor of the animal body. What anatomists have called animal spirits, *aura seminalis*, may possibly not exist; and it is certainly not these spirits which agitate the particles seen moving in the seminal liquors; but we will here relate the principal observations that have been made on this subject.

Leeuwenhoeck observed, in the semen of a cock, animals which resemble the figure of an eel, but so exceedingly minute, that he pretends fifty thousand would not equal in size a grain of sand; and in that of a rat many millions would be required to make the thickness of a hair, &c. This observer imagined that the whole substance of the semen was only a mass of these animalcules. He perceived these animalculæ in the semen of men, quadrupeds, birds, fishes, insects, &c. In that of grasshoppers they were long and slender. They are attached, he says, by their extremities, and the inferior of which he calls the tail, had a quick motion, like that of the tail of a serpent, when the upper part is motionless. He further adds, that in the semen of young animals the animalculæ are motionless, but as the age for reproduction

duction comes on they move about with great vivacity.

In the semen of a male frog he observed animalculæ, at first they were imperfect and motionless, but some time afterwards he found them living: they were so very small, he says, that ten thousand would scarcely equal the size of a single egg of the female. It was only those in the seminal liquor of the frog which had life and motion.

In the semen of a man, and that of a dog, he pretends to have seen two kinds, which he looked upon as males and females. Having inclosed the seed of a dog in a vial, he says, that numbers of the animalculæ died the first day; the second and third there died still more, and very few remained alive the fourth. But having repeated this experiment on the semen of the same dog, he found, at the end of seven days, live animalculæ, some of which swam with as much swiftness as in fresh-extracted semen; and having opened a bitch which had been three times with the same dog, he could not perceive by the naked eye any seminal liquor of the male in either of the horns of the matrix; but by help of a microscope he discovered the spermatic animals of the dog

 in

in both horns of the matrix, and great numbers of them in that part of the matrix adjoining to the vagina, which, says he, evidently proves that the male semen enters the matrix, or at least that the spermatic animals of the dog had got there by their own motion, which is sufficient to carry them four or five inches in half an hour. In the matrix of a doe rabbit, which had just received the buck, he likewise observed an infinite number of spermatic animals; he says, that their bodies are round, with long tails, and that they often change their forms, especially when the humid matter in which they swim evaporates and dries.

Leeuwenhoeck's experiments have been frequently repeated and found conformable to truth. There have been some inclined to exceed him in these discoveries. Dr. Dalenpatius having observed the seminal liquor of a man, not only pretended to have discovered animals like tadpoles, whose bodies appeared nearly the size of a grain of wheat, and their tails four or five times longer than their bodies, and which moved with great agility, but, what is still more marvellous, he observed one of these animals quit its covering; upon which it was no longer an animalcule, but had become

a human

a human body, the two legs of which, he affirms, were very discernible, as were the arms, breast, and head.* But by the figures which this author has given of this pretended embryo, it is evident his assertion is false. He might suppose he saw what he relates, but he was mistaken; for the embryo, such as he describes, was more formed on quitting this covering, and the state of a spermatic worm, than it would have been at the end of a month or five weeks in the matrix of its mother; therefore this observation of Dalenpatius, instead of having been confirmed by other observations, has been rejected by every naturalist, the most exact and accurate of which have only discovered, in the seminal liquor of man, round and oblong bodies, which seemed to have long tails, but without any kind of members.

It might be said that Plato had spoken of these spermatic animals which become human forms; for he says, "Vulva quoque matrix que in fœminis eadem ratione animal avidem generandi, quando procul a fœtu per ætatis florem, aut ultra diutius detinetur, ægre fert

* See Nouvelles de la Republique des Lettres. Ann 1699, page 552.

fert moram ac plurimum indignatur, passimque per corpus oberrans, meatus spiritus intercludit, respirare non finit, extremis vexat angustiis, morbis denique omnibus premit, quosque utrorumque Cupido amorque quasi ex arboribus fœtum fructumve producunt, ipsum deinde decerpunt, & in matricem velut agrem inspargunt; hinc animalia primum talia, ut nec propter parvitatem videantur, necdum appareant formata, concipiunt: mox quæ conflaverant, explicant, ingentia, intus enutriunt, demum educunt in lucem, animaliumque generationem perficiunt." Hippocrates, in his treatise *De Diæta*, seems also to insinuate, that the seed of animals is replete with animalcules. Democritus speaks of certain worms which take the human figure, and Aristotle says, that the first men came out of the earth in the form of worms; but neither the authority of Plato, Hippocrates, Democritus, Aristotle, nor the observation of Dalenpatius, can make us receive the idea that these spermatic worms are small human bodies, concealed under a covering; for it is evidently contrary to experience and observation.

Valisnieri and Bourgúet, whom we have quoted, discovered small worms in the seed of

a rabbit, one of whose extremities was thicker than the other; they were very lively and active, struck the liquor with their tails, and twisted and turned themselves like snakes. At last (says Valisnieri) I clearly perceived them to be real animals, "e gli riconobbi, e gli giudicai senza dubitamento alcuno per veri, verissimi arciverissimi vermi*." This author, who was prejudiced with the system of eggs, has, nevertheless, admitted of spermatic worms, and taken them for real animals.

M. Andry having made observations on these spermatic worms of a man, pretends that they are only found in the age proper for generation; that in the younger years, and in old age, they do not exist: that in those affected with venereal disorders there are very few, and those are languishing, and for the most part dead: that in impotent persons we do not see any alive; that these worms in the semen of men have larger heads than in that of other animals, which agrees, he says, with the figure of the fœtus and the child; and he adds, those people who too frequently enjoy female amours, have generally but few or none of these animalcules in their semen.

Leeuwenhoeck,

* Opere dell. Cav. Valisnieri, vol. II. page 105.

Leeuwenhoeck, Andry, and many others, strenuously opposed the egg system; they had discovered in the semen of all males living animalcules; they proved that these animalcules could not be regarded merely as dwelling in this liquor, since their bulk was greater than that of the liquor itself; and that nothing like them was found either in the blood, or in the other animal liquors. They asserted, that females furnished nothing similar, nothing alive; and it was therefore evident that the fecundity attributed to them belonged, on the contrary, to males alone: and that the discovery of these spermatic animals in the semen tended more to the explanation of generation than all that had been before supposed; since, in fact, what was most difficult to conceive in generation, was the production of the living part, all the rest being only accessary operations, and therefore no doubt could remain but these little animals were destined to become men, or perfect animals of their kind. When it was opposed to the partizans of this system, that it did not seem natural to suppose that so many millions of animalcules, every one of which might become a human being, should be employed for a purpose of which one alone was to reap the

advantage;

advantage; when it was asked them, why this useless profusion of the shoots of human beings? they answered, that it was only consonant with the common munificence of nature: that out of many millions of seeds which plants and trees produce, but a very few succeed, and therefore we must not be surprised at the same circumstance in spermatic animals. When the infinite minuteness of the spermatic worm, compared to man, was objected to them, they answered, by the example of the seed of trees; and they added, with some foundation, metaphysical reasonings, by which they proved that great and small being only relations, the transition from small to great, or from great to small, was executed by nature with still more facility than we can conceive.

Besides, continue they, have we not very frequent examples of transformation in insects? do we not see small aquatic worms become winged animals, by only throwing off their coats, which were their apparent and external forms? and may not spermatic animals, by a similar transformation, become perfect animals? All therefore, they conclude, concurs to favour this system of generation, and confuting that founded on eggs; and if there are eggs in vivi-

 parous

parous females, the same as in the oviparous, these eggs will only be the necessary matter for the growth of the spermatic worm, which enters into the egg by the pedicle that adheres to the ovarium, and where it meets with food ready prepared for it. All the worms which find not this passage through the pedicle into the egg will perish, and that one which alone has traced its way will arrive at its transformation. The difficulty of meeting with the passage in the pedicle of the egg, can only be compensated by the infinite number of spermatic worms. It is a million to one that any particular spermatic worm will meet with the pedicle of the egg, and therefore what at first appears a profusion is highly necessary. When one has entered, no other can introduce itself, because, say they, the first worm entirely shuts up the passage, or there is a valve at the entrance of the pedicle, which is free when the egg is not absolutely full; but when the worm has filled the egg, the valve can no longer open although impelled by another worm. This valve is very well imagined, because, if the first worm should chance to return, it opposes its egress, and obliges it to remain and undergo the transformation. The spermatic worm then becomes the fœtus, the substance

substance of the egg its food, the membranes, its covering, and when the nutriment in the egg is nearly exhausted, the fœtus adheres to the internal skin of the matrix, and thus derives nourishment from the parent's blood, till by its weight, and augmentation of its strength, it breaks through its imprisonment, and comes perfect into the world.

By this system it was not the first woman who inclosed all mankind, but the first man who contained all posterity in his body. The pre-existing germs are no longer embryos without light, inclosed in the eggs, and contained one in another, ad infinitum; but they are small animals, the little homunculæ organized and actually living, included in each other in endless succession, and to which nothing is wanting for them to become perfect animals, and human beings, but expansion, assisted by a transformation similar to that which winged insects undergo.

As our present physicians are divided on these two systems of spermatic worms and eggs, and as all those who have lately written on generation have adopted one or the other of these opinions, it seems necessary to examine them with care, and to shew that they are not

only sufficient to explain the phenomena of generation, but are also founded on suppositions void of all probability.

Both suppose an infinite progression; which, as we have said, is not so much a reasonable supposition as an illusion of the mind. A spermatic worm is more than a thousand million times smaller than a man; if, therefore, we suppose the body of a man as an unit, the size of the spermatic worm can only be expressed by the fraction $\frac{1}{1000000000}$; and as man is with respect to the spermatic worm of the first generation, what this worm is to that of the second generation, the size of the last spermatic worm cannot be expressed but by a number composed of nineteen cyphers; and so likewise the size of the spermatic worm of the third generation will require 28 cyphers; that of the fourth generation 37; the fifth 46, and the sixth 55 cyphers. To form an idea of the minuteness represented by this fraction, let us take the dimensions of the sphere of the universe from Sol to Saturn, and supposing the sun a million times larger than the earth, and about a thousand solar diameters distant from Saturn, we shall perceive that only 45 cyphers are required to express the number of cubic lines

 contained

contained in this sphere; and, by reducing each cubic line into a thousand millions of atoms, 54 cyphers are only required to express that number; consequently a human being will be greater, with relation to a spermatic worm of the sixth generation, than the sphere of the universe is with relation to the smallest atom which is possible to be perceived by the assistance of a microscope. What would it be if we were to carry it to ten generations? The minuteness would be so great as to leave us no mode of expressing it. The probability of this opinion, therefore, evidently disappears in proportion as the object diminishes. This calculation may be applied to eggs as well as spermatic worms, and the want of probability is general to both; it will, no doubt, be said, that matter being divisible, *ad infinitum*, there is no impossibility in this diminution of size; and although it is not probable, yet we must regard this division of matter as possible, since we can always, by thought, divide an atom into a number of parts. But I answer, that the same illusion is made use of on this infinite divisibility as on every other geometrical and arithmetical infinity; they are only abstractions of the mind, and have no existence in nature.

If

If we look on infinite divisibility of matter as an absolute infinity, it is easy to demonstrate that in that sense it does not exist; for, if once we suppose the smallest atom possible, by that supposition this atom will necessarily be indivisible, since if it were divisible it would no longer be the smallest atom possible, which would be contrary to the supposition. It therefore seems to me, that every hypothesis where a progress, *ad infinitum*, is admitted, ought to be rejected not only as false, but as void of all probability; and as the system of eggs and spermatic worms supposes this progress, they should not be admitted in philosophy.

Another great difficulty against these two systems is, that in the egg system the first woman contained the male and female eggs: the male eggs contained only a generation of males; and that, on the contrary, the female eggs contained thousands of generations, both of males and females; insomuch that, at the same time, and in the same woman, there was always a certain number of eggs capable of developing themselves to infinity, and another number which would be unfolded but once. The same circumstance must occur in the other system, and therefore I ask if there is

the

the smallest appearance of probability in these suppositions?

A third difficulty arises against these two systems, which is, the resemblance that children bear, sometimes to the father and sometimes to the mother, and sometimes to both; and the evident marks of extraordinary difference in mules, &c. If from the spermatic worm of the father the fœtus is produced, how can the child resemble the mother; and if the fœtus is pre-existing in the egg of the mother, how can the child resemble its father? or if the spermatic worm of a horse, or the egg of a she-ass contains the fœtus, how can the mule participate in the nature and figure of both the horse and the ass?

These general difficulties, which are invincible, are not the only ones that can be made against these systems; there are particular ones which are no less potent. To begin with the system of spermatic worms, may it not be asked of those who admit of it, how they think this transformation is made? and object to them, that insects have not, nor cannot have any relation with what they suppose. For the worm which is to become a fly, or the caterpillar which is to become a butterfly, passes through a middle

a middle state, and when it ceases to be a chrysalis, it is completely formed and has acquired its full size, and is then in a condition of engendering; whereas in the pretended transformation of the spermatic worm into man, it cannot be said to be in a state of chrysalis, and even if we should suppose one during the first days of conception, why does not the production of this chrysalis, instead of an unformed embryo, suppose an adult and perfect being? We plainly see how analogy is here violated; and that far from confirming this idea of the transformation of the spermatic worm, it is instantly destroyed by examination.

Besides, the worm which is transformed into a fly proceeds from an egg; the egg is the produce of the copulation of the male and female, and includes the fœtus, which must afterwards enter into a chrysalis, before it arrives at its state of perfection, as a fly; in which form alone it has an engendering power; whereas the spermatic worm has no faculty of generation, nor proceeds from an egg. Even should we allow the semen to contain eggs, from whence issue spermatic worms, the same difficulty will still remain, for these supposed eggs have not the copulation of the two

sexes

sexes for their principle of existence, as in insects; consequently the partizans of that opinion cannot pretend any similarity, nor derive any advantage from the transformation of insects; which rather destroys the basis of their explanation.

When the innumerable multitude of spermatic worms are opposed to those physicians who are prejudiced by this system, they answer, as before observed, by the examples of plants and trees. But this comparison is not entirely just, because all the spermatic worms excepting one perish by absolute necessity, which is not the case with the seeds of a tree or plant, for those which do not become vegetables, serve as food for other organized bodies, and for the expansion and reproduction of animals; whereas we do not see any use for the spermatic worms, or any end to which we can refer their prodigious superfluity. On the whole, I only make this remark in reply to what is, or may be said on this matter; for I own, that no arguments drawn from final causes will either establish or destroy a physical system.

Another objection made against this opinion is, there being, to all appearance, an equal

 number

number of separate worms in the seed of all kinds of animals, for, say they, it is natural to imagine, that in those kinds where fœtuses are most abundant, as in fishes, insects, &c. the number of spermatic worms should be more numerous than in those where generation is least abundant, as in man, quadrupeds, birds, &c. for if they are the immediate cause of production, why is there no proportion between their number and that of the fœtus? Besides, there is no proportionable difference in the size of most kinds of spermatic worms, those of large animals being as small as those of the least. Those of a rat, and those of a man, are nearly the same, and when there is any difference it is no ways relative to the size of the individual. The Calmar, which is a very small fish, has spermatic worms above one hundred thousand times larger than those of a man or a dog. Another proof these worms are not the immediate and only cause of generation.

The particular difficulties that may be raised against this egg system are no less considerable. If the fœtus exists in the egg before the communication of the male with the female, why do we not perceive the fœtus as well in those eggs produced before as after copulation? We

have before recounted the observations of Malpighius, who says he always found the fœtus in those eggs produced by hens that had received the cock, and only a mass or mole in the cicatrice of those who had not; it is therefore very clear that the fœtus does not exist in the egg till after impregnation.

Another difficulty against this system is, that not only the fœtus is not seen in eggs before the junction of the sexes, but even the existence of eggs in viviparous animals is by no means proved. Those physicians who pretend that the spermatic worm is the fœtus enveloped in a covering, are at least assured of spermatic worms; but those who affirm that the fœtus is pre-existing in the egg, have no proof of the existence of the egg itself; on the contrary, there is a probability, almost equivalent to a certainty, that these eggs do not exist.

Although the partizans of the egg system do not agree what must be looked on as the true egg in the female testicle, nevertheless they all think that impregnation is made in the testicle called the *ovarium*, without paying any attention that if it was so most fœtuses would be found in the abdomen instead of the matrix,

for the superior extremity of the trunk being separated from the ovarium, the pretended eggs must often fall into the abdomen. Now, it is certain that this case is extremely rare, and, I believe, never happened, unless occasioned by some accident.

The general difficulties and objections against these two systems have been noticed by the author of *Venus Physique*, whose treatise, although very short, has more philosophical ideas than there are in many folio volumes on generation. As this book is very public, and the accuracy with which it is written will not permit any extract, I shall only observe, this author is the first who has returned into the road of truth, from which we were farther strayed than ever, since the supposition of the egg system, and the discovery of spermatic animals. Nothing therefore remains farther to be said, and I shall conclude with relating a few particular experiments, some of which have appeared favourable, and others contrary, to these systems.

In the History of the Academy of Sciences of Paris, 1701, some objections are proposed by M. Mery against the egg system. This able anatomist supports, with reason, that the

vesicles found in the female testicles are not eggs, but are so adherent to the internal substance of the testicle that they cannot be naturally separated therefrom; that if they could separate themselves from this substance it would be impossible for them to get out, because the common membrane, which surrounds all the testicle, is a web of too firm a texture to admit of a conception; that a vesicle, or round soft egg, could open a passage in it; and as the greatest number of physicians and anatomists were prejudiced in favour of the egg system, and, from the experiments of De Graaf, believed that the number of cicatrices in the testicles marked the number of fœtuses, M. Mery mentions the testicles of a woman, where there was such a quantity of these cicatrices, that, agreeable to this system, would have supposed a fecundity almost beyond imagination. These difficulties excited other partizans of the egg system to make new researches. M. Duverney examined and dissected the testicles of cows and sheep: he pretended that the vesicles were eggs, because there were some less adherent to the testicles than others, and insisted it was natural to believe, that when they came to perfect maturity they were separated altogether,

gether, especially as by inflating the internal cavity of the testicle the air passed between these vesicles and the adjoining parts. M. Mery only answers that this is not a sufficient proof, since these vesicles have never been seen separate from the testicles. M. Duverney remarked the glandular bodies on the testicles, but he did not look on them as an essential and necessary part towards generation, but merely as accidental exuberances, like gall-nuts on the oak. M. Littre, whose prejudice for the egg system was still greater, pretended, not only that the vesicles were eggs, but even asserted he had discovered in one of them a well-formed fœtus, of which he distinguished the head and trunk very perfectly, and even gave the dimensions. But besides this wonder being only seen by that gentleman, and no other naturalist, it is sufficient to read his Memoire* to perceive how doubtful was the fact. By his own words we find the matrix was schirrhous, that the testicle was corrupted, and that the vesicle, or egg, which contained this imaginary fœtus was smaller than the other vesicles, or eggs, which did not contain any thing, &c.

A famous

* Anno 1701, page 3.

A famous experiment, in favour of the egg system, is supplied by De Nuck; he opened a bitch three days after copulation; he drew out one of the horns of the matrix, and made a ligature in the middle, so that the upper part of the passage could have no communication with the lower; after which he replaced this horn, and closed up the wound, with which the bitch seemed but little incommoded. At the end of twenty-one days he opened it again, and found two fœtuses in the upper part, that is between the testicles and the ligature; but in the lower part there was no fœtus. In the other horn of the matrix, which had not been tied by a ligature, he found three fœtuses, which were regularly disposed, which proves, he says, that the fœtus does not proceed from the seed of the male, but exists in the female egg. Supposing this experiment, which has only been made once, was always followed with the same effect, we should not then be right in concluding that fecundation is made in the ovary, and that eggs are detached therefrom which contain the fœtus completely formed. It would only prove that the fœtus may be formed in the upper parts of the horns of the matrix as well as in the lower; and it seems very natural

tural to imagine that the ligature, compressing the middle of the horns of the matrix, impelled the seminal liquors, which are in the lower parts, to issue out, and thus destroy the business of generation in them.

Thus we have gone through the opinions of anatomists and physicians on the subject of generation; and it now only remains for me to recount what I have been enabled to draw from my own researches and experiments, and it will then be seen whether my system is not infinitely more agreeable to Nature than any of those I have given an account of.

CHAPTER

CHAPTER VI.

EXPERIMENTS ON THE METHOD OF GENERATION.

I OFTEN reflected on the above system, and was every day more and more convinced that my theory was infinitely the most probable. I then began to suppose that, by a microscope, I might be able to attain a discovery of the living organic particles, from which I thought every animal and vegetable drew their origin. My first supposition was, that the spermatic animalcules seen in the seed of every male, might possibly be these organic particles; on which I reasoned as follows:

If every animal and vegetable contain a quantity of living organic particles, these par-

ticles would be found in their seed, and in a greater quantity than in any other substance, because the seed is an extract of what is most analogous to the individual, and the most organic; and the animalcule we see in the seed of males are, perhaps, only these same living organic molecules, or at least the first union, or assemblage of them. But if this is so, the seed of the female must also contain similar living organic molecules, and, consequently, we ought to find moving bodies there as well as in the male: and since the living organic particles are common both to animals and vegetables, we should also find them in the seeds of plants, in the nectarium, and in the stamina, which are the most essential parts of vegetables, and which contain the organic molecules necessary for reproduction. I then seriously thought of examining the seminal liquors of both sexes, and the germs of plants, with a microscope. I thought, likewise, that the reservoirs of the female seed might possibly be the cavities of the glandular bodies, in which Valisnieri and others had uselessly sought for the egg; and at length determined to undertake a course of observations and experiments. I first communicated my ideas to Mr. Needham,

ham, a gentleman well known for his microscopical observations, and read to him the first part of this work; he seemed to approve of these ideas, and did me the favour to lend me his microscope, which was infinitely superior to my own. At the same time I communicated my system and project of experiments to Messrs. Daubenton, Gueneau, and Dalibard, all of whom encouraged me to persevere in my determination, and from whom, in the course of making those experiments, I received much assistance, particularly from Mr. Daubenton.

Persons not experienced in the use of the microscope will not be displeased that I here insert some remarks which will be useful to them, if they repeat the following experiments, or make new ones. We should give the preference to double microscopes, in which we see objects perpendicularly, from their having a plain or concave mirror, which shews the objects clear; the concave mirror is the most preferable when the observations are made with the strongest lens. Leeuwenhoek, who undoubtedly has been the greatest and most indefatigable of all microscopical observators, is said to have only made use of simple microscopes, with which he

viewed objects horizontally. If this is true, it is necessary to remark, that most of the plates given by Leeuwenhoek of microscopical objects, especially spermatic animals, represents them much thicker and longer than he really saw them, which renders the microscopes we speak of preferable to the horizontal, as they are more stable; the motion of the hand, with which the microscope is held, producing a little trembling, which causes the object to appear wavering, and never presents the same part for any time. Besides, there is always a motion in the liquors caused by the agitation of the external air, at least, if we do not put the liquor between two plates of glass, or even fine talc, which diminishes somewhat of its transparency, and greatly lengthens the experiment; but the horizontal microscope, whose tables are vertical, has the still greater inconvenience, that the most ponderous parts of the drop of liquor fall to the bottom; consequently there are three motions, that of the trembling of the hand, the agitation of the fluid by the action of the air, and also that of the parts of the liquor falling to the bottom: from the combination of which, certain small globules, which we see in these liquors,

quors, may appear to move by their own motion and powers, while they only obey the compounded power of those three causes.

When we put a drop of liquor on the table of the double microscope, although horizontally placed, and in the most advantageous situation, we still see one common motion in the liquor, which forces all what it contains to one side. We must wait till the fluid is in an equilibrium and at rest, before we make our observations; for it often occurs, that this motion of the fluid hurries away many globules, and forms a kind of whirling motion, which returns one of these globules in a very different direction to the others. The eye is then fixed on the globules, and seeing one take a different course from the rest, supposes it an animal, or at least a body, which moves of itself, whereas its motion is only owing to that of the fluid; and as the liquor is apt to dry and thicken in the circumference of the drop, endeavours must be made to fix the lens on the centre of it. The drop should also be as large as possible, and contain as much liquor as will permit a sufficient transparency, to see perfectly what it contains.

Before

Before we begin to make observations, we should have a perfect knowledge of our microscope. There is no glass whatsoever but in which there are some spots, bubbles, threads, and other defects, which should be nicely inspected, in order that such appearances should not be represented as real and unknown objects: we must also endeavour to learn what effect the imperceptible dust has which adheres to the glasses of the microscope; a perfect knowledge of which may be acquired by observing the microscope several times.

To make proper observations, the sight, or focus, of the microscope must not precisely fall on the surface of the liquor, but a little above it; as not so much reliance should be placed on what passes upon the surface, as what is seen in the body of the liquor. There are often bubbles on the surface which have irregular motions produced by the contact of the air.

We can see much better with the light of two short candles, than in the brightest day, provided this light is not agitated, which is avoided by putting a small shade on the table, inclosing the three sides of the lights and the microscope.

It

It will often appear as though dark and opaque bodies become transparent, and even take different colours, or form concentrical and coloured rings, or a kind of rainbow on the surface; and other matters, which are seen at first sight transparent and clouded, become black and obscure; these changes are not real, but only depend on the obliquity the sight falls on the body with, and the height of the plain in which they are found.

When there are bodies in a liquor which seem to move with great swiftness, especially when they are on the surface, they form a furrowed motion in the liquor, which appears to follow the moving body, and which we might be inclined to mistake for a tail. This appearance deceived me at first, but I clearly perceived my error, when these little bodies met others which stopped them; for there was no longer any appearance of tails. These are the remarks which occurred during my experiments, and which I submit to those who would make use of the microscope for the observation of liquors.

EXPERIMENTS.

I. I took from the seminal vessels of a man, who died a violent death, and whose body was still warm, all the liquor therein contained, and put it into a small bottle; of this I put a drop on the table of the microscope, without the addition of water or any other liquor. The first thing which presented, was a vapour which steamed from the liquor towards the lens, and obscured it. These vapours being dissipated, I perceived large filaments, (*fig.* 1.) which in some places seemed to extend into different branches, and in others to intermingle together. These filaments clearly appeared to be internally agitated by an undulating motion, and looked like hollow tubes which contained some moving substance. I distinctly saw two of these filaments (*fig.* 2.) were joined together, and had a vibration nearly like that of two extended strings, which are tied at the two extremities, and pulled asunder in the middle. These filaments were composed of globules which touched each other, and resembled beads. I afterwards saw filaments which swelled in cer-

tain

PLATE. I.

FIG. 1

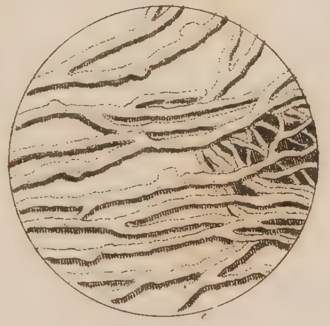


FIG. 2

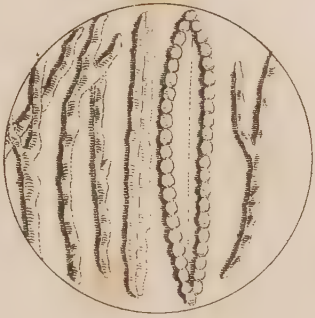


FIG. 3

FIG. 4

FIG. 5

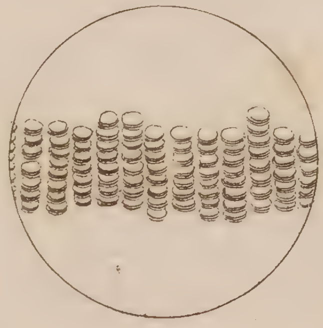
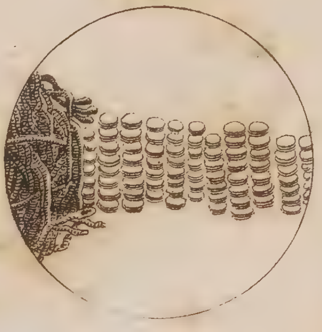


FIG. 6



tain parts, and I observed, that on the side so swelled small globules came out, which had a distinct motion like that of a pendulum; these small bodies were fastened to the filaments by a small thread, (*fig.* 3.) which lengthened gradually as the little body moved; and at last I saw these little bodies entirely separated from the large filament, carrying after them the small thread which connected them. As this liquor was very thick, and the filaments too near each other, I dilated another drop with rain water, in which I was assured there were no animals. I then saw the filaments much separated, and very distinctly perceived the motion of these little bodies, which was now more free, and they swam much quicker; and if I had not seen them separate from the filaments, and carry along with them their thread, I should have taken the moving body in this second observation for an animal, and the thread for its tail. I then attentively observed one of these filaments, that was much thicker than these small bodies, and I had the satisfaction of seeing two of those bodies which separated with difficulty, drag along with them a long and small thread, which obstructed their motion.

This seminal liquor was at first very thick, but by degrees it became more fluid; in less than an hour it was almost transparent; and in proportion as this fluidity increased, the phenomena changed, as I shall relate.

II. When the seminal liquor attained more fluidity, the filaments were no longer to be seen, but the little bodies appeared in great numbers; they have for the most part a motion like that of a pendulum, and they draw after them a long thread, which it may clearly be perceived they want to get rid of; their motion forwards is very slow, vibrating to the right and left. The motion of a boat fastened in the midst of a rapid stream to one fixed point, pretty well represents the motion of these bodies, excepting that the boat remains in the same place, whereas they advance by degrees; but they do not always keep the same parts in the same direction; but at each vibration they take a considerable rolling motion; so that, besides their horizontal motion, they have one of a vertical balance, which proves that these bodies are of a globular figure, or, at least, that their lowest part is not sufficiently extended to maintain them in the same position.

III. At

III. At the end of two or three hours, when the liquor was more fluid, we saw a greater quantity of these moving bodies. They seemed to be more free; the threads were shorter; their progressive motion was more direct, and their horizontal motion was greatly diminished; for the longer the threads are, the greater is the angle of their vibration; and in proportion as these threads diminish in length, the vibratory motion lessens, and the progressive motion increases. The vertical balance still subsisted, and was always plainly perceptible.

IV. In five or six hours the liquor attained its utmost fluidity. Most of these moving substances were entirely disengaged from their threads; they were of an oval figure, (*fig.* 4.) and moved progressively with great swiftness, and by their various motions had a stronger resemblance than ever to real animals. Those who had their threads still adhering, were not so brisk as the others; and among these that had not threads, some seemed to change their shape and size, some were round, some oval, and others thicker at their extremities than in the middle; the balancing and rolling motion was still observable.

V. At the end of twelve hours a kind of gelatinous matter was settled at the bottom of the bottle: it was of an ash-colour, and of a tolerable consistency; the liquor that swam above was almost as clear as water, with a kind of bluish tint, resembling water in which a little soap had been dissolved; nevertheless it still preserved its viscidity. The moving bodies had then a great activity, were loosened from their threads, and moved in all directions. I saw some of them change their form, and from oval become round; and others separate, and from one oval form two. As they became smaller, their activity encreased.

VI. In twenty-four hours the liquor had deposited a greater quantity of gelatinous matter. I diluted it with water, but it did not readily mix, and required a considerable time to dissolve. It then appeared composed of an infinite number of opaque tubes that formed a kind of net-work, in which no regular disposition nor the least motion could be seen: in the clear liquor some few small bodies were still moving. The next morning there were also a very few; but after that time I saw no more in this liquor than in the globules, without any appearance of motion.

These

These experiments were repeated several times with the most possible exactness; and I am persuaded that those threads above mentioned are not tails, nor do they make any part of the individual body; for these threads have no proportion with the rest of the body; they are of different sizes, although the moving bodies are always nearly of the same, at the same time. The globule appears embarrassed in its motion, as its tail is longer or shorter; sometimes it cannot advance, but move only from right to left, or from left to right, when the tail is very long; and it is clearly seen that they use great efforts to get rid of them.

VII. Having taken the seminal liquor from another man but just dead, and still warm, I put a drop of it on the table of the microscope, and it immediately liquified; it had at first a condensed appearance, and seemed to form a compact web, composed of long and thick filaments, which grew from the thickest part of the liquor. These filaments separated in proportion as the liquor became more fluid, and at length they divided into globules, which at first seemed not to have sufficient power to set

themselves

themselves in motion, but this power increased as they separated from the filament, from which they made many efforts to disengage themselves. Each of them in this struggle drew out tails from the filaments of different sizes, some of which were so thin and so long as to have no proportion with the bodies, which were all so much the more embarrassed as these threads or tails increased in length. The angle of their vibratory motion was also much greater as those filaments were longer: and their progressive motion so much the more remarkable as these tails were shorter.

VIII. Having continued these observations for fourteen hours, I perceived that these threads, or tails, were continually lessening, and became so fine, that at last their extremities were no longer visible, and at length the whole entirely disappeared. At this time the globules absolutely ceased their horizontal vibrations; their progressive motion was direct, although they had always the vertical balancing motion, like the rolling of a ship. When disencumbered of these threads, the bodies were oval, transparent, and perfectly like those pretended animals seen in the liquor of an oyster on

on the seventh day, and still more to those found in the jelly of roast veal at the end of the fourth day.

IX. Between the tenth and eleventh hour the liquor became extremely fluid, and all the globules appeared to proceed in ranks from one and the same side; (*fig.* 5.) they passed over the table of the microscope in less than four seconds; they were ranged seven or eight in front, and moved on successively, as troops march in files. I observed this singular instance for more than five minutes; and as their course did not finish, I was desirous of finding the source: and, having gently moved my glass, I perceived that all these moving globules came from a kind of mucilage, (*fig.* 6.) where the filamentary net-work continually produced them more abundant and much quicker than the filaments had ten hours before. There was still a remarkable difference between these moving bodies produced in the thick liquor, and those produced when the liquor became more fluid; these last had no thread behind them, their motion was quicker, and they went in flocks like sheep. I observed the mucilage from whence they issued for some time, and perceived it diminished, and was suc-

cessively converted into moving globules, till the diminution of more than half the bulk; after which, the liquor being too dry, this mucilage became obscure in its middle, and all the environs were divided by the small threads which appeared to be formed from the bodies of these moving globules which were destroyed as it dried up, not in one single mass, but in long threads, regularly disposed, with quadrangular intervals, forming a net-work, very like to a cobweb, on which the moisture hung in an infinite number of globules.

X. I perceived by the first experiment, that these little moving bodies change their form, and I thought they in general diminished, but of that I was not certain. In this last observation, at the twelfth and thirteenth hour I observed it more distinctly; at the same time remarking that though diminished considerably in size, yet they increased in specific gravity; especially when their motion was nearly finished, which generally happened all at once and they sunk to the bottom, forming a sediment of an ash-colour, plainly perceptible to the naked eye, and which appeared through the microscope to be composed of globules adherent to one another, sometimes by threads, and

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at others in knots, but always in a regular manner.

XI. Having procured the seed of a dog, emitted naturally, I observed that this liquor was clear, and had but little tenacity. I put it in a phial, and having examined it with a microscope, without diluting it with water, I perceived moving bodies entirely like those I had observed in the human semen; they had threads, or tails, perfectly the same; they were also nearly of the same size; in a word, they resembled, as perfectly as possible, those I saw in the human liquor, liquified during two or three hours. I then sought for the filaments which I had seen in the human liquor, but it was useless; I perceived only some long threads entirely like those which served as tails to the globules. These threads were not attached to any globules, nor had they any motion. Those globules which were in motion, and had tails, appeared to me to move quicker than those in the human semen: they had scarcely any horizontal vibrations, but a rolling motion. They were not in a great number; and, although their progressive motion was stronger, they took more time to cross the microscope than those I had before remarked. I observed this

this liquor for three hours, but perceived no change: after which I examined it at another time for four hours, and remarked, that the number of moving bodies diminished by degrees; the fourth day there was still some, though they were very few, and often I only found one or two in a drop of liquor. The second day most of them were deprived of their tails; the third day very few retained them, yet, at the last day, there still remained some which had them; the liquor had then deposited a whitish sediment, which appeared to be composed of immoveable globules, and many threads, that seemed to be tails separated from the globules. There were also some attached to the globules, which appeared to be the dead bodies of these little animals, but whose forms were different from those that moved, for they appeared larger than the moving globules, or the rest, which remained without motion at the bottom of the liquor, and appeared to have a fissure or opening.

XII. Another time, having taken the seminal liquor of the same dog, I again perceived the fore-mentioned phenomena; and I saw, besides, in one of the drops of this liquor, a mucilaginous part, which produced moving globules,

globules, as in the ninth experiment, (*fig.* 6.) and these globules formed a current, and went in ranks like troops. This mucilage appeared to me animated with an internal inflated motion, which produced small bloated appearances in different parts, and from whence issued these bloated forms, or moving globules, with a nearly-equal swiftness, and in the same direction. The bodies of these globules were not different from the rest, excepting they had no tails. I observed that many of them changed their shape, and lengthened considerably, till they became little cylinders, after which the two extremities of the cylinders were bloated, and divided into two globules, both moving and following the same direction as that before they were united.

XIII. The phial, which contained this liquor, having been broke by accident, I, a third time, took the liquor of the same dog, but whether the animal was wearied by too reiterated emissions, or by other causes, the seminal liquor contained none of the above bodies, but was transparent and viscous, like the serum of blood; I examined it then, and at one, two, three, and even twenty-four hours afterwards, but it presented nothing new: there

was not a single moving body to be seen, nor any mucilage; in a word, nothing that I had seen before.

XIV. I then opened a dog, and separated the testicles and the adherent vessels, but I perceived no seminal vesicles, and apparently the seed in those animals passes directly from the testicles into the urethra. I found but a small quantity of liquor in the testicles, although the dog was adult and vigorous. In the small quantity I could collect I could not discover any bodies that were in motion. I only perceived a great quantity of very small globules, most of which were motionless, and some of the smallest had some trifling approximating motion, which I could not follow, because the drops I gathered were so exceedingly minute that they dried in two or three minutes after they were placed in the microscope.

XV. Having cut the testicles of this dog into two parts, I infused it in water, and closely sealed up the vessel. Three days after I examined this infusion, which I made with the design of discovering whether the flesh did not contain moving bodies, and I saw a great quantity of moving bodies of a globular and oval form, like those I had seen in the seminal

liquor of the dog, excepting they had not any threads. They moved in all manner of directions with great swiftness. I observed these bodies, which appeared animated for some time, and saw many change their form; I perceived some to lengthen, and others to contract, while some swelled at both extremities: there were numbers that were smaller and thicker than the rest; but they were all in motion, and were about the size and figure of those I have described in the fourth experiment.

XVI. The next morning the number of these globules were increased, but they appeared smaller; their motion was more rapid and irregular; they had also another appearance with respect to their form and manner of moving, which seemed confused; the next and several days after, till the fifteenth day, there were moving bodies in the water, whose size gradually diminished till they were no longer visible. The last, which I perceived with great difficulty, was on the nineteenth and twentieth days, and they moved with greater rapidity than ever. Upon the water a kind of pellicle was formed, which appeared to be composed of the coverings of those moving bodies, small threads, scales, &c. but entirely motionless;

motionless; this pellicle, and the moving bodies could not come into the liquor by means of external air, since the bottle had been kept carefully sealed.

XVII. I then successively opened ten rabbits, on different days, to examine their seminal liquors; the first had not a drop, either in the testicles or seminal vessels. In the second I was no more successful, although I was assured he was the father of a very numerous progeny. I succeeded no better in the third. I then imagined that the presence of the female might be requisite; I therefore put males and females into cages so contrived that it was impossible for them to copulate. At first these endeavours did not succeed; for, on opening two, not a drop of seminal liquor was to be found; however, in the sixth that I opened, a large white rabbit, I found, in the seminal vesicles, as much liquor as could be contained in a teaspoon; this matter resembled calves' jelly, was nearly transparent, and of a citron colour. Having examined it with the microscope, I perceived it to resolve, by slow degrees, into filaments and thick globules, many of which appeared fastened to each other; but I did not remark any distinct motion in them, only as the matter

matter liquefied, it formed a kind of current by which these filaments and globules seemed to be drawn all to one side. I expected to find this matter take a greater degree of fluidity, but that did not happen, for, after it was a little liquefied, it dried, and I could perceive nothing further than what is above mentioned. When this matter was mixed with water, the latter did not appear to have power to dilute it.

XVIII. Having opened another rabbit, I only found a very small quantity of seminal matter, which was of a colour and consistency entirely different from the former; it was scarcely tinctured of a yellow hue, and was much more fluid. As there was but very little, I feared it would dry too hastily, and therefore mixed it with water: from the first observation, I did not perceive the filaments I had seen in the other, but I discovered three globules, all in a trembling and restless motion; they had also a progressive motion, but it was very slow; some moved round the others, and most appeared to turn upon their centres. I could not pursue this observation because the liquor so soon got dry.

XIX. I opened another of these rabbits, but could not discover any of this matter; in the seminal vessels of another, I found almost

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as much congealed liquor as in XVIIIth Experiment: I examined it in the same manner as the rest, but it afforded me no greater discovery. I infused the whole I had collected, in almost double the quantity of water, and after briskly shaking them together, I suffered them to settle for ten minutes; after which, on inspecting this infusion, I saw the same large globules as before; there were but few and those very distant from each other. They had approximating motions with respect to each other, but they were so slow, as to be scarcely discernable; two or three hours after, these globules seemed to be diminished, their motion was become more distinct, and they appeared to turn upon their centres. Although this trembling motion was more than their progressive, nevertheless they were clearly seen to change their situation irregularly with respect to each other. Six or seven hours after the globules were become still less, and their action was increased: they appeared to me to be in much greater numbers, and all their motions distinct. The next morning there was a prodigious multitude of globules in motion, which were at least three times smaller than those that at first appeared. I observed these globules for eight days, and observed that many of them seemed

seemed to join together, after which their motion ceased; this union, however, appeared to me only superficial and accidental. Some were larger than others; most were round and spherical, and some of them were oval. The largest were most transparent, and the smallest were almost black. This difference did not proceed from the light, for in whatever situation these small globules were in, they were always of the same appearance; the motions of the small were much more rapid than the large ones, and what I remarked most clearly and most generally in all, was their diminution of size, so that at the eighth day they were so exceedingly small as to be hardly perceptible, and at last absolutely disappeared.

XX. At length having obtained, with no small difficulty, the seminal liquor of another rabbit, as it would have been conveyed to the female, I remarked it to be more fluid than that which had been taken from the seminal vesicles, and the phenomena which it offered were also very indifferent; for in this liquor there were moving globules and filaments without motion; and also a kind of globules with threads or tails, resembling those of a dog or a man, but only appearing smaller and brisker (*fig.* 7.)

(*fig.* 7.) They passed over the microscope in an instant, their tails appeared shorter than those of other spermatic animals, and I own I am not certain whether some of those tails were not false appearances, produced by the furrows which these moving globules formed in the liquor, as they moved with too great a rapidity to admit of my clearly observing them; besides, the liquor, though sufficiently fluid at first, very speedily dried away.

XXI. After this I resolved to examine the seminal liquor of a ram; I applied to a butcher, who supplied me with the necessary parts of at least twelve or thirteen, directly after they were killed, but I could not find liquor sufficient for any experiment, either in the epididymis or seminal vesicles. In the little drops I was able to collect, I only perceived globules which had no motion. As I made these experiments in March, I supposed by repeating them in October, the season of female attachments, I should discover more seminal liquor in these vessels. I cut many of these testicles in two longitudinally, and collected a small quantity of liquor, but found nothing more in them.

XXII. I took three of these testicles, of three different rams, cut each of them into four parts,

PLATE. II

FIG.7

FIG.8

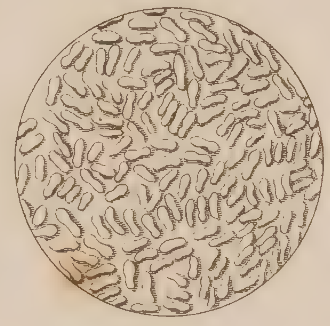


FIG.9

FIG.10

FIG.11

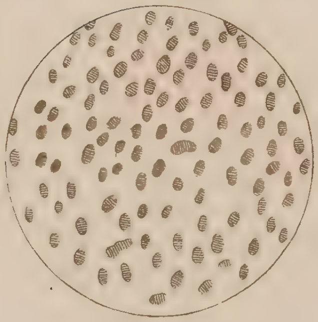
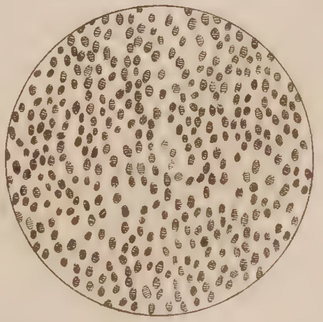


FIG.12



parts, and put them into separate bottles, with as much water as was sufficient for them. Securing these bottles from the admission of air I suffered the infusion to remain for four days, after which I examined the liquor of each by the microscope, and found them all replete with an infinity of moving bodies, most part of which were oval, and the rest globular; they were pretty thick, and resembled those described in the VIIIth experiment; their motion was neither brisk, uncertain, nor very rapid, but equal, uniform, and in all directions. These moving bodies were nearly of the same size in each liquor, but differed one bottle with the other. They had no tails, nor were there any filaments or threads in this liquor; during the fifteen or sixteen days they were retained, they often changed their form, and seemed successively to throw off their external coverings; they also became every day smaller, and on the sixteenth day, they were no longer perceptible.

XXIII. In the month of October I opened a ram, and found a great quantity of seminal liquor in the epididymis; having examined it with the microscope, I perceived an innumerable multitude of moving bodies, so nu-

merous, that all the liquor seemed to be entirely composed of them; as it was too thick, I diluted it with water, but I was surprised to see the motion of these bodies suddenly stop, though I perceived them very distinctly; having many times repeated the same observation, I perceived that the water which diluted the seminal liquors of a man, a dog, &c. seemed to coagulate that of a ram.

XXIV. I then opened another ram, and in order to prevent the seminal liquor from coagulating, I permitted the parts of generation to remain in the body of the animal, and covered it over with warm clothes. By these precautions I observed the seminal liquor in its fluid state; it was replete with an infinity of oblong moving bodies, (*fig.* 8.) traversing in various directions; but as soon as the liquor grew cold, the motion of all these bodies immediately ceased. I diluted the liquor with warm water, when the motion of the small bodies remained for three or four minutes. The quantity of these moving bodies was so great in this liquor, that although diluted, they nearly touched each other. They were all of the same size and form, but none of them had tails. Their motion was not very quick, and when

when it stopped by the coagulation of the liquor, they did not change their form.

XXV. As I was persuaded, not only by my own theory, but also by the observations of all those who had made experiments before me, that the female, as well as the male, has a seminal and prolific liquor; and, as I had no doubt, but the reservoir of this liquor was the glandular body of the testicle, where prejudiced anatomists attempted to find the egg, I purchased several dogs and bitches, and some male and female rabbits, which I kept separate from each other; and in order to have a comparative object with the liquor of the female, I again observed the seminal liquor of a dog, and discovered there the same moving bodies as described in the XIth experiment.

XXVI. While I was thus occupied, a bitch was dissected which had been four or five days in heat, and had not received the dog. The testicles were readily found, and on one of them I discovered a red, glandular, prominent body, about the size of a pea, which perfectly resembled a little nipple; on the outside was a visible orifice formed by two lips; one of which jutted out more than the other.

Having

Having introduced a small instrument into this orifice, a liquor dropped from it, which we carefully caught to examine with the microscope. The surgeon replaced the testicles in the body of the animal, which was yet alive, in order to keep them warm. I then examined this liquor with a microscope, and, at the first glance, had the satisfaction to see moving bodies with tails, exactly like those I just before saw in the seminal liquor of the dog. (*fig.* 9.) Messrs. Needham and Daubenton, who observed them with me, were so surprized at this resemblance, that they could scarcely believe but that these spermatic animals were the same, and thought I had forgotten to change the table of the microscope, or that the instrument with which we had gathered the liquor of the female, might before have been used for the dog. Mr. Needham then took different instruments, and having obtained some fresh liquor, he examined it first, and saw there the same kind of animals, and was convinced, not only of the existence of spermatic animals in the seminal liquor of the female, but likewise of their resemblance to those of the semen of the male. We repeated it

it ten times at least, in different drops of the same liquor, without perceiving the smallest variation in the phenomena.

XXVII. Having afterwards examined the other testicle, I found a glandular body in its growing state; it had not any external orifice, was much smaller, and not so red as the first. Having opened it, I found no liquor; but only a small fold in the internal part, which I judged to be the origin of the cavity that was to contain the liquor. This second vesicle had some very small lymphatic vesicles externally. I pierced one of them with a lancet, and a clear and limpid liquor flowed out, which I examined with the microscope; it contained nothing similar to that of the glandular body; it was a clear matter, composed of small globules, which were motionless. Having often repeated this observation, I was assured, that this liquor in the vesicles was only a kind of lymph, which contains nothing animated, or similar to that seen in the female seed, which is formed and perfected in the glandular bodies.

XXVIII. Fifteen days after I opened another bitch that had been in heat seven or eight

days,

days, but had not received the dog. I found the testicles contiguous to the extremities of the horns of the matrix; these horns were very long, their external tunic surrounded the testicles, and they appeared covered with that membrane like a cowl. In each testicle I found a glandular body in its full maturity. The first was half open, and there was a passage which penetrated into the testicle, and which was replete with seminal liquor; the second was somewhat more large and prominent, and the orifice, or canal, which contained the liquor was below the nipple. I took these two liquors, and having compared them, found them perfectly alike. The seminal liquor of the female is at least as liquid as that of the male. Having afterwards examined the two liquors with the microscope, I perceived the like moving bodies, (*fig.* 10.) and the same phenomena, as in the seminal liquor of the other. I saw besides many globules which moved very briskly, and endeavoured to disengage themselves from the mucilage that surrounded them: there was a great quantity of them as in the seed of the female.

XXIX. From these glandular bodies I pressed out all the liquor, and having collected

it, I found enough to last for four or five hours observations. I remarked that it deposited somewhat to the bottom, or at least began to thicken. I took one drop of this, which was thicker than the rest, and having put it on the microscope, perceived that the mucilaginous part of the seed was condensed, and formed a continued network. On the external border of this network, there was a torrent, or current, composed of globules, which moved with rapidity. These globules were lively, active, and appeared to be disengaged from their mucilaginous covering, and their tails. This stream perfectly resembled the course of the blood in small transparent veins; for they appeared not only to be animated by their own powers, but also to be impelled by a common force, and constrained to follow in a herd. From this experiment, and the XIth and XIIth, I concluded, that when the fluid begins to coagulate and thicken, these active globules break and tear their mucilaginous coverings, and escape by that side where the liquor remains most fluid. These moving bodies had then neither threads nor tails; they were for the most part oval, and appeared to be flat at the bottom, for they had no rolling motion.

XXX. The horns of the matrix were externally soft; I opened them longitudinally, and only found a very small quantity of liquor, which, upon examination, appeared to contain the same as that pressed from the glandular substance of the testicle. These glandular bodies are placed so as easily to sprinkle this liquor on the horns of the matrix; and I am persuaded that, as long as the amorous season remains, there is a continual dropping of this liquor from the glandular substance into the horns of the matrix; that this dropping remains till the glandular substance has emptied the vesicles; it then becomes fluid by degrees, is effaced, and only leaves a little reddish cicatrice on the external part of the testicle.

XXXI. I took this seminal liquor of the female, with the same quantity of that just emitted from the male, and mixed them together, and having examined this mixture with the microscope, I perceived nothing new, the liquor remaining the same, and the moving bodies were so similar, that it was impossible to distinguish those of the male from those of the female; I only thought their motion appeared a little slackened.

XXXII. Having dissected a young bitch that had never been in heat, I only discovered a small

a small protuberance on one of the testicles, which I supposed to be the origin of a glandular body. The surface of the testicles was smooth and even, and the lymphatic vessels could scarcely be seen externally, until the tunic, which covered the testicles, was separated; but these vesicles were not considerable, and contained but a small quantity of liquor, in which I could only perceive some little globules without any motion.

XXXIII. In another bitch, which was younger, and only three or four months old, there was no appearance of glandular bodies on the testicles; they were white, smooth, and covered with a cowl like the rest. There were some little vesicles which contained little or no liquor; and it was with great difficulty we could perceive any vesicles externally. I compared one of these testicles with that of a young dog of nearly the same age, and they appeared internally of a fleshy nature, and perfectly similar. I do not mean to contradict what some anatomists have said concerning the testicles of dogs, but only that the appearance of the internal substance of the female testicles is like that of the males, when the glandular substances are not yet grown.

XXXIV. The genital parts of a cow, which had been just killed, was sent to me, covered over with hot cloths, and put into a basket with a live rabbit, which likewise squatted on a cloth at the bottom, so that I received them almost as warm as when taken out of the body. I immediately inspected the testicles, and found them of the size of a hen's, or, at least, a pigeon's egg. One of these testicles had a glandular body, about the size of a pea, protuberating outwardly like a small nipple, but it was not pierced, nor had any external orifice: it was close and hard. I pressed it with my fingers, but no liquor issued from it. I observed, before this testicle was dissected, there were two other glandular substances at a distance from the other; but these were just begun to grow; their colour was a whitish yellow, whereas that which seemed to have pierced the membrane of the testicle was of a rose colour. I opened this last, and examined it with the greatest attention, but could not discover that it contained any liquor, I therefore judged that it was far distant from its maturity.

XXXV. The other testicle had no glandular body which had pierced the common

membrane that covered the testicle, there were only two small ones, which began to form a little protuberance below this membrane. I opened both of them but no liquor issued therefrom: they were hard, whitish, and with a little yellow tint; each of them had four or five lymphatic vesicles, very easily distinguishable on their surface, and appearing transparent. I judged they contained a quantity of liquor, and having pierced them with a lancet, the liquor issued out to some inches distance. I collected a sufficient quantity of this liquor to observe it easily; I only saw some very minute immoveable globules; and although I continued my examination for two days, I neither discovered alteration, change, nor motion, therein.

XXXVI. Eight days after, two more genital parts were brought to me in the same mode as the last. I was assured that one was taken from a young cow that had never calved, and the other from one that had had several, but was not old. I first examined the testicles of the latter, and on one of them I found a glandular substance, as large and as red as a cherry, which appeared a little soft towards the nipple. I distinguished three small holes, in which

which a hair might be introduced. Having pressed this substance with my fingers a small quantity of liquor issued, which I placed on the table of a microscope, and had the satisfaction to see some moving globules there, but quite different from those which I had seen in other seminal liquors (*fig.* 11.). These globules were obscure and little; their progressive motion, although distinct, was, nevertheless, very slow. The liquor was not thick; the little globules had no appearance of threads, or tails, and they were not all in motion. This is all I was able to perceive in the liquor this glandular substance afforded me, for although I pressed it again, it only afforded a less quantity, mixed with blood. I again discovered it in the small moving globules, but they seemed to be at least four times smaller than the sanguinary globules.

XXXVII. This glandular body was situate at one of the extremities by the side of the horn of the matrix, and the liquor, which it prepares, must fall upon this horn; nevertheless, on opening this horn I found no material quantity of liquor. This glandular body penetrated very forward in the testicle, and occupied more than a third of its internal substance.

stance. I opened them longitudinally, and found a pretty large cavity, but entirely void of any liquor. At some distance from this glandular body there was a small one of the same kind, about the size of a lentil. There were also two small cicatrices, about the same size, which formed two small indentions, of a deep red colour: they were the remains of obliterated glandular bodies. Having afterwards examined the other testicle, I counted four cicatrices and three glandular bodies; the foremost of which had pierced the membrane, was of a flesh colour, and the size of a pea. It was solid, and without any orifice or liquor: the two others were smaller, harder, and of a deep orange colour. On the first testicle only two or three apparent lymphatic vesicles remained. I counted eight on the external part, and having examined the liquor of these vesicles I perceived only a transparent matter, without any moving bodies.

XXXVIII. I then examined the testicles of the young cow which had not calved, which, notwithstanding, were something larger than the other, but it is true there were no cicatrices on either of them; the one was smooth and very white, and a number of lymphatic vesicles

vesicles were sprinkled about it, but there was not the least mark of a glandular body. On the other testicle I perceived the marks of two glandular substances, the one had just began to grow, and the other was the size of a pea; there was also a great number of lymphatic vesicles, which I pierced with a lancet, but the liquor did not contain any thing; having pierced the two small glandular bodies some blood alone issued thereout.

XXXIX. I divided each testicle of both cows into four parts, and, having put them into separate phials, I poured as much water on as would cover them, and after having closely corked them up, I suffered to infuse for six days; I then examined these infusions, and discovered an innumerable quantity of living moving bodies (*fig.* 12.); they were all, in these infusions, extremely small, moved with a surprising rapidity in all directions. I observed them for three days, and they always appeared to diminish, till at last, on the third day, they entirely disappeared.

XL. The following day they brought to me the genital parts of three more cows. I immediately searched the testicles to find one where the glandular substance was in perfect maturity

maturity; but in two of them I only discovered some growing glandular substances on the testicles. I could not learn whether these cows had calved or not, but there was a great appearance they had all been in season, for there were a great number of cicatrices on all these testicles. In the third I found a testicle, on which was a glandular substance, as thick and as red as a cherry; it was inflamed, and seemed to be in full maturity. Its extremity was a nipple, with a small hole; I pressed it a little between my fingers, and a quantity of liquor issued out. I found in this liquor moving globules, exactly like those in the liquor pressed from the glandular body of the other cow, I have before spoken of in experiment XXXVI. They appeared to be more numerous, their progressive motions were not so slow, and their size larger. Having observed them for some time I perceived some to lengthen and change their form. I then introduced a very fine instrument into the little hole of the glandular substance, and having opened it I found the internal cavity replete with liquor; this liquor offered me the same phenomena, and the same moving globules, as I before observed in experi-

ment xxxvi. with either filaments, threads, or tails attached to them. The liquor of the vesicle presented me with nothing more than nearly a transparent matter, which did not contain one moving thing.

XLI. At different times they brought me the genitals of several other cows. In some I found the testicles loaded with an almost mature glandular substance; in others they were of different growths, and I remarked nothing new, excepting that in the two testicles of two different cows I perceived the glandular substance in a decayed state; the base of one was as broad as the circumference of a cherry; the extremity of the nipple was soft, wrinkled, and shrivelled; the two small holes were very perceptible, from whence the liquor had flowed. With some difficulty I introduced a small hair, but there was no liquor in the canal, nor in the internal cavity, which was still to be seen. The flaccidity of these glandular substances begins, therefore, at the most external part, or extremity of the nipple. They diminish at first in height, and afterwards in breadth, as I observed in another testicle, where this glandular substance had diminished more than three fourths.

XLII. As

XLII. As the testicles of doe rabbits, as well as the glandular bodies formed there, are very small, I could observe nothing very exactly with respect to their seminal liquor. I only discovered, that the testicles of doe rabbits are different, and that none of those I saw resembled what De Graaf represents in his engravings; for the glandular substances did not enclose the lymphatic vesicles; and I never saw a pointed end, as he has depicted them.

XLIII. I found on the testicles of some cows a kind of bladders, replete with transparent liquor. I remarked they were of different sizes, the largest about that of a pea; they were fastened to the external membrane of the testicle by a strong membraneous pedicle, as was also another, still smaller; and a third, nearly of the same size as the second, appeared to be only a lymphatic vesicle, much more apparent than the rest. I imagined these bladders, which the anatomists have called *hydatides*, might possibly be of the same nature as the lymphatic vesicles of the testicles, for having examined the liquor they contained I found it to be perfectly similar; it was a

transparent and homogeneous liquor, which did not contain one moving substance.

XLIV. At the same time I made observations on the liquor in an oyster; on the water in which pepper had been boiled; on the water wherein pepper had been only infused; and on the water wherein I had put some vegetable seed; the bottles which contained these waters were firmly closed, and in two days I perceived in the oyster liquor a great quantity of oval and globular substances, which seemed to swim like fish in a pond, and had all the appearance of being animals; however they had no limbs nor tails, but were very large, transparent, and visible. I perceived them change their forms, and become smaller for seven or eight days successively; and at length I and Mr. Needham observed animals similar to those in an infusion of jelly of roast veal, which had been also very exactly corked; so that I am persuaded they are not real animals, at least according to the received acceptation of the words, as we shall hereafter explain.

The infusion of the seed presented an innumerable multitude of moving globules which appeared animated like those of the seminal

liquors,

liquors, and in the infusions of the flesh of animals: these were also large, and in violent motion during the first days, but they diminished by degrees, and disappeared only from their minuteness.

I perceived the same thing, but later, in the liquor wherein pepper had been boiled, and the like, though still later, in that which had not boiled; from hence I supposed that what is called fermentation may possibly be only the effect of the motion of these organical parts of animals and vegetables; and in order to see what difference there was between this kind of fermentation and that of minerals, I placed a little powdered stone on the microscope, and sprinkled thereon a drop of aquafortis, which however produced a different phenomena, consisting of great balls, which ascended to the surface, and almost instantaneously obscured the focus of the microscope: this was a dissolution of the grosser parts, which being completed it became motionless, and had not the smallest resemblance to the other infusions I had observed.

XLV. I examined the seminal liquor in the roes of different fish; such as carp, tench, barbel, &c. which I took out while they were liv-

ing,

ing, and having observed three different liquors with great attention, I perceived a great quantity of obscure globules, all in motion. I took several more of these fish alive, and with my fingers gently compressed that part of the belly where this liquor is emitted; and in that which I obtained, I perceived an infinity of moving globules therein, very black and very small.

XLVI. Before I finish this chapter I shall relate the experiments of Mr. Needham on the seed of a kind of cuttle fish, called calmar. This able naturalist having sought for spermatic animals in the milts of many different fish, found them in the roe of a calmar, apparent to the naked eye. During the summer he dissected calmars at Lisbon, but found no appearance of any roe, nor any reservoir which appeared to be destined for the reception of the seminal liquor; and it was in the middle of December that he began to discern the first traces of a new vessel replete with a milky juice. This reservoir increased, and the seed which it contained was diffused very abundantly. By examining this liquor with the microscope, he perceived only small opaque globules, which floated in a kind of serous matter, without the least appearance of life. But some time after,

in the milt of another calmar, he found these organic parts completely formed; they seemed like spiral springs shut up in a kind of trasparent case. They appeared as perfect at first as they did at last, excepting that by degrees they contracted and formed a kind of screw. The lid of the case was a species of valve that opened outwardly, and by which all the contents might issue; it contained another valve, a barrel, and a spongy substance; therefore the whole machine consisted in an external, transparent, and cartilaginous case, whose upper extremity is terminated by a round head, formed by the case itself, and which performs the office of a valve. In this external case is contained a transparent tube, which encloses the spring, piston, or valve, barrel, or spongy substance. The screw occupies the upper part of the tube and case, the piston and barrel are placed in the middle, and the spongy substance occupies the lower part. These machines pump up the lacteal liquor, of which the spongy substance is full; and before the animal spawns, the whole milt is no more than a composition of these organic parts, which have absolutely pumped up the lacteal liquor. As soon as these little machines are taken from the body of the animal, and de-

posited

posited either in water, or held in the air, they begin to act; the spring ascends, followed by the piston, the barrel, and the spongy substance which contains the liquor; and as soon as the spring and the tube which contain it begin to quit the case, the spring folds up; and all that remains within begins to move, till the spring, the sucker, &c. are entirely come out: as soon as that is done, the remainder immediately follow, and the lacteal liquor, which has been pumped out, and which was contained in the spongy substance flows out by the barrel.

As this observation is very singular, and incontestibly proves that the moving bodies found in the milt of the calmar are not animals, but simple machines, a kind of pumps, I have deemed it necessary to give Mr. Needham's own words.*

"When the small machines, he says, are arrived to their perfect maturity, many of them act the moment they are in the open air; nevertheless most of them may be commodiously placed, so as to be seen with a microscope, before their action begins; and even to make them act, the upper extremity of the external case

* See New Discoveries made with the microscope by Mr Needham, chap. vi. Leyden, 1747.

case must be moistened with a drop of water which then begins to expand, while the two small ligaments which issue from the case twist and turn in different manners: at the same time, the screw ascends slowly, the volutes, which are at its upper end, approach and act against the top of the case: those at the bottom also advance, and seem to be continually followed by others which come from the piston. I say, they seem to be followed, because I do not think they are so effectually, but only a deception produced by the nature and motion of the screw. The piston and barrel also follow the same direction, extend lengthways, and at the same time move towards the top of the case, which is perceived by the vacuum at the bottom. As soon as the screw, with the tube in which it is enclosed, begins to appear externally from the case, it folds, because it is retained by its two ligaments: nevertheless, all the internal contents continue to move gently and gradually, until the screw, piston, and bladder, are entirely come out. When that is done, the rest follow directly after. The piston separates from the barrel, and the apparent ligament, which is below the latter, swells

 and

and acquires a diameter equal to that of the spongy substance which follows it. This, although much larger than when in the case, becomes still five times longer than before. The tube which incloses it all is straightened in its middle, and forms two kinds of knots, about a third of its length distant from each extremity: the semen then flows through, and is composed of small opaque globules, which float in a serous matter, without shewing any signs of life, and which are precisely such as I have said to have seen them when they were diffused in the reservoir of the milt. In the figure, the part between the two knots seems to be broken: when it is examined attentively, we find that what causes it to appear as such, is, that the spongy substance within the tube is broken in nearly equal pieces, which the following phenomena will clearly prove. Sometimes it happens, that the screw and the tube break by the piston, which remains in the barrel; then the tube closes in a moment, and takes a conical figure, by contracting, as much as it is possible, above the end of the screw, which demonstrates its great elasticity in that part: and the manner in which it accommodates itself with the figure of the substance it incloses, when

when it receives the least change, proves, that it is equal in every other respect."

Mr. Needham from this conceives that we might imagine the actions of all this machine were owing to the spring of the screw, but he proves, by many experiments, that the screw, on the contrary, only obeys a power which resides in the spongy part. As soon as the screw is separated from the rest, it ceases its action, and loses all its activity. The author afterwards makes this reflection on this singular machine:

"If, says he, I had seen the animalcule pretended to be in the semen of living animals, perhaps I might be in a condition to determine whether they are really living creatures, or simple machines prodigiously minute, and which are in miniature, what the vessels of the calmar are in the great."

By this, and some other analogies, Mr. Needham concludes, there is a great appearance that the spermatic worms of other animals are only organized bodies and machines, like to those of the calmar, whose actions are made at different times; "for, says he, let us suppose, that in the prodigious number of sper-

matic worms seen on the table of a microscope, there are some thousands which act at the same time, that will be sufficient to shew us, they are all alive. Let us also conceive, adds he, that the motion of these spermatic worms remains, like that of the machines of the calmar, about half a minute; then the succession of action of these small machines, will remain a long time, and the pretended animals will appear to decrease successively. Besides why should the calmar alone have machines in its seed, whereas every other animal has spermatic worms, and real animals? Analogy is here of such great weight, that it does not appear possible to refuse it." Mr. Needham likewise very justly remarks, that even the observations of Leeuwenhoek, seems to indicate that the spermatic worms have a great resemblance with the organized bodies in the seed of the calmar. "I have, says Leeuwenhoek, speaking of the cod, taken those real substances for hollow and extended animalcule, because they were four times as large as the living animalcule." And in another part, "I have remarked, he says, speaking of the seed of a dog, that the animalcules often change their form, especially when the

the liquor in which they float evaporates. The progressive motion does not extend above the diameter of a hair."*

After considering all these circumstances Mr. Needham conjectures, that the supposed spermatic animals might possibly be only natural machines, substances much more simply organized than the bodies of animals. I have seen with the microscope, these machines in the calmar, and the description he gives of them, is very faithful and exact. His observations then shew us, that the seminal liquor is composed of parts which seek to be organized; that it, in fact, produces organized substances, but that they are not as yet, either animals or organized substances, like the individual which produced them. We might suppose, that these substances are only instruments which serve to perfect the seminal liquor, and strongly impel it; and that it is by their brisk and internal action, that it most intimately penetrates the seminal liquor of the female.

CHAPTER

* See Leeuwenh. Arch. Nat. page 306, 309, 310.

CHAPTER VII.

COMPARISON OF MY OBSERVATIONS WITH THOSE OF LEEUWENHOEK.

ALTHOUGH I made the preceding experiments with all the circumspection possible; and although I repeated them a number of times, I am persuaded that many things escaped my notice; I have only related what I saw, and what all the world may see, with a little art and much practice. In order to be free from prejudices, I endeavoured to forget what other naturalists asserted to have seen, conceiving that by so doing, I should be more certain of only seeing in fact what really appeared;

peared; and it was not till after I had digested my observations, that I compared them with those of Leeuwenhoek, &c. I by no means pretend to have greater abilities in microscopical observations than that great naturalist, who passed more than sixty years in making various experiments.

Notwithstanding the authority his observations may justly claim, it is surely permitted to examine and compare others with them. Truth can only be gained by such examinations, and errors discovered, particularly as we do it without any partiality, and in the sole view of establishing something fixed and certain on the nature of those moving bodies seen in the seminal liquors.

In November 1677, Leeuwenhoek, who had already communicated to the Royal Society of London many microscopical observations on the optic nerve, the blood, the juice of the plants, the texture of trees, rain-water, &c. addressed to Lord Brouncker, President of the Society, in the following words: "Postquam Exc.* &c. Dominus Professor Cranen me visitatione sua sæpius honorarat, litteris rogavis, Domino Ham concrato suo, quasdam

* See Phil. Trans. No. 141. page 1041.

quasdam observationum mearum, videndas darem. Hic dominus Ham me secundo invisens, secum in laguncula, vitrea semen viri, gonorrhæa laborantis, sponte destillatum, attulit, dicens, se post paucissimas temporis minutias (cum materia illa jam in tantum esset resoluta ut fistulæ vitreæ immitti posset) animalcula viva in eo observasse, quæ caudam & ultra 24 horas non viventia judicabat; idem referebat se animalcula observasse mortua post sumptam ab ægroto therebintinam. Materiam prædicatam fistulæ vitreæ immissam, præsente Domino Ham, observavi, quasdamque in ea creaturas viventes, at post decursum 2 aut 3 horarum eamdem solus materiam observans, mortuas vidi.

" Eamdem materiam (semen virile) non ægroti alicujus, non diuturna conservatione corruptam, vel post aliquot momenta fluidiorem factam, sed sani viri statim post ejectionem, ne interlabentibus quidem sex arteriæ pulsibus, sæpiuscule observavi, tantamque in ea viventium animalculorum multitudinem vidi, ut interdum plura quam 1000 in magnitudine arenæ sese moverent; non in toto semine, sed in materia fluida crassiori adhærente, ingentem illam animalculorum multitudinem observavi

observavi; in crassiori vero seminis materia quasi sine motu jacebant, quod inde provenire mihi imaginabar, quod materia illa crassa ex tam variis cohæreat partibus, ut animalcula in ea se movere nequirent; minora globulis sanguini ruborem adferentibus hæc animalcula erant, ut judicem, millena millia arenam grandiorem magnitudine non æquatura. Corpora eorum rotunda, anteriora obtusa, posteriora ferme in aculeum desinentia habebant; cauda tenui longitudine corpus quinquies sexiesve excedente, & pellucida crassitiem vero ad 25 partem corporis habente prædita erant, adeo ut ea quoad figuram cum cyclaminis minoribus, longam caudam habentibus, optime, comparare queam; motu caudæ serpentino, aut ut anguillæ in aqua natantis progrediebantur; in materia vero aliquantulum crassiori caudam octies deciesve quidem evibrabant antequam latitudinem capilli procedebant. Interdum mihi imaginabar me internoscere posse adhuc varias in corpore horum animalculorum partes, quia vero continuo eas videre nequibam, de iis tacebo. His animalculis minora adhuc animalcula, quibus non nisi globuli figuram attribuere possum, permissa erant.

 "Memini

"Memini me ante tres aut quatuor annos, rogatu Domini Oldenburg, B. M. semen virile observasse, & prædicta animalia pro globulis habuisse; sed quia fastidiebam ab ulteriori inquisitione, & magis quidem a descriptione, tunc temporis eam omisi. Jam quoad partes ipsas, ex quibus crassam seminis materiam, quoad majorem sui partem consistere sæpius cum admiratione observavi, ea sunt tam varia ac multa vasa, imo in tanta multitudine hæc vasa vidi, ut credam me in unica seminis gutta plura observasse quam anatomico per integrum diem subjectum aliquod secanti occurrant. Quibus visis, firmiter credebam nulla in corpore humano jam formato esse vasa, quæ in semine virili bene constituto non reperiantur. Cum materia hæc per momenta quædam aëri fuisset exposita, prædicta vasorum multitudo in aquosam magnis oleaginosis globulis permistam materiam mutabatur, &c."

The Secretary of the Royal Society, in answer to this letter, says, that it would be proper to make the like experiments on the seed of other animals, as dogs, horses, &c. not only to form a better judgment on the first discovery, but to know the differences which

might

might be found in the number, and the figure of those animalcules. And with relation to the vessels of the thickest part of the seminal liquors, he greatly doubts they were only filaments without any organization, "quæ tibi videbatur vasorum congeries, fortassis seminis sunt quædam filamenta, haud organice constructa, sed dum permearunt vasa generationi inservientia in istiusmodi figuram elongata. Non dissimili modo ac sæpius notatus sum salivam crassiorem ex glandularum faucium foraminibus editam quasi e convolutis fibrilis constantem."*.

Leeuwenhoek answered him on the 18th of March, 1678, in the following words: "Si quando canes coeunt marem a fœmina statim seponas materia quædam tenuis & aquosa (lympha scilicet spermatica) e pene solet paulatim exstillare; hanc materiam numerosissimis animalculis repletam aliquoties vidi, eorum magnitudine quæ in semine virili conspiciuntur, quibus particulæ globulares aliquot quinquagies majores permiscebantur.

"Quod ad vasorem in crassiori seminis virilis portione spectabilium observationem atti-

 net,

* See the Secretary's answer to Leeuwenhoek's Letter in the Phil. Trans. No. 141, page 1043.

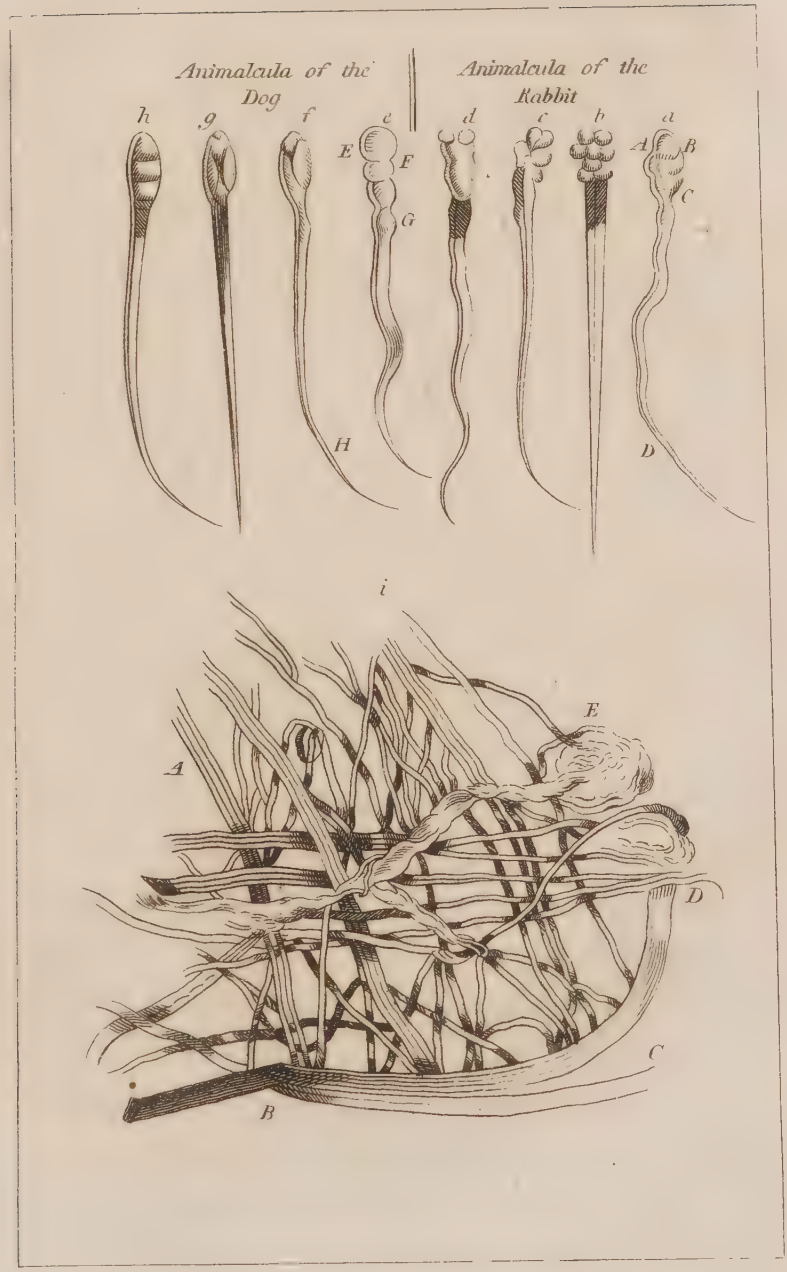
net, denuo non semel iteratam, saltem mihimetipsi comprobasse videor; meque omnino persuasum habeo, cuniculi, canis, felis, arterias venasve fuisse a peritissimo anatomico haud unquam magis perspicue observatas, quam mihi vasa in semine virili, ope perspicilli, in confectum venere.

"Cum mihi prædicta vasa primum innotuere, statim etiam pituitam, tum & salivam perspicillo applicavi; verum hic minime existentia animalia frustra quæsivi.

"A cuniculorum coitu lymphæ spermaticæ guttulam, unam et alteram, e femella exstillantem, examini subjeci, ubi animalia prædictorum similia, sed longe pauciora, comparuere. Globuli item quam plurimi, plerique magnitudine animalium, iisdem permisti sunt.

"Horum animalium aliquot etiam delineationes transmisi, figura *a (plate 3.)* exprimit eorum aliquot vivum (in semine cuniculi arbitror) eaque forma qua videbatur, dum aspicientem me versus tendit. A B C, capitulum cum trunco indicant; C D, ejusdem caudam, quam pariter ut suam anguilla inter natandum vibrat. Horum millena millia, quantum conjectare est, arenulæ majoris molem vix superant,

PLATE. III.


Animalcula of the Dog
Animalcula of the Rabbit
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rant, (*fig. b*; *c*, *d*,) sunt ejusdem generis animalia, sed jam mortua.

"(*Fig. e.*) Delineatur vivum animalculum, quemadmodum in semine canino sese aliquoties mihi attentius intuenti exhibuit. E F G, caput cum trunco indigitant, G H ejusdem caudam, (*fig. f*, *g*, *h*,) alia sunt in semine canino quæ motu & vita privantur, qualium etiam vivorum numerum adeo ingentem vidi, ut judicarem portionem lymphæ spermaticæ arenulæ mediocri respondentem, eorum ut minimum decena millia continere."

By another letter written to the Royal Society, the 31st of May, 1678, Leeuwenhoek adds, "Seminis canini tantillum microscopio applicatum iterum contemplatus sum, in eoque antea descripta animalia numerosissime conspexi. Aqua pluvialis pari quantitate adjecta, iisdem confestim mortem accersit. Ejusdem seminis canini portiuncula in vitreo tubulo unciæ partem duodecimalem crasso servata, sex & triginta horarum spatio contenta animalia vita destitua pleraque, reliqua moribunda videbantur.

"Quo de vasorum in semine genitali existentia magis constaret, delineationem eorum aliqualem mitto, ut in figura A B C D E, (*fig. i.*)

 quibus

quibus literis circumscriptum spatium arenulam mediocrem vix superat."

I have copied these first remarks of Leeuwenhoek from the Philosophical Transactions, because, in matters of this kind, observations made without any systematical view are those which are the most faithfully described, and even this able naturalist no sooner formed a system on spermatic animals, than he began to vary in essential points.

It is evident by the above dates, that Hartsoeker is not the first who published, if he was the first who discovered spermatic animals. In the Journal de Sçavans, in the year 1774, there is a letter from Mr. Huguens, on the subject of a microscope, made by one small ball of glass, with which he asserts he perceived animals in the water, wherein pepper had been infused for two or three days, as Leeuwenhoek before had observed with the like microscopes, but whose balls were not so minute. "There are also other seeds, he continues, which engender such animals, as coriander seeds, &c. and I have seen the same thing in the pith of the birch tree, after having kept it for four or five days; and some have observed them in the water where nutmegs and cinnamon have

been

been soaked. These animals may be said to engender from some corruption or fermentation: but there are others which must have a different origin; as those in the seed of animals, which seem in such great numbers, as to be almost composed of them; they are all transparent, have a quick motion, and their figures are like the tadpole."

Huguens does not mention the author of this discovery; but in the Journal of the 29th of August in the same year, there is an extract of a letter of M. Hartsoeker, in which he gives the method of forming these glass balls by means of the flame of a lamp; and the author of the Journal says, "By this method he has discovered that little animals are engendered in urine which has been kept for some days, and have the figure of little eels: he found some in the seed of a cock, which appeared of the same form, but quite different from those found in the seed of other animals, which resemble tadpoles, or young frogs, before their legs are formed." The author seems to attribute the invention to Hartsoeker; but if we reflect on the uncertain manner in which it is there represented, and on the particular manner in which Leeuwenhoek speaks in his letter, written and published above

a year

a year before, we must allow him to be the first who made this observation; but between them a contest took place as to the discovery which has never been decided. Be this as it will, Leeuwenhoek was undoubtedly the first inventor of the microscope, whose focuses are balls of glass formed by the flame of a lamp. But to return to his observations.

I shall first remark, that what he says of the number and motion of these pretended animals is true; but the figure of the body is not always the same as he describes it: sometimes the part which precedes the tail is round and at others long; often flat, and frequently broader than it is long, &c. and with respect to the tail, it is often much larger and shorter than he asserts. The motion of vibrations which he gives to the tail, and by means of which he pretends that the animalcules advance progressively in this fluid, has never appeared to me as he has described it. I have seen these moving substances make eight or ten oscillations from the right to the left, or vice versa, without advancing the breadth of a hair; and I have even seen many more which could not advance at all; because this tail, instead of being of any assistance to

them,

them was, on the contrary, a thread attached either in the filaments or mucilaginous parts of the liquor, and rather retained the moving substance like as a thread fastened to the point retains the ball of a pendulum; and when this tail had any motion, it only resembled a thread which forms a curve at the end of an oscillation. I have seen these threads, or tails, fastened to the filaments which Leeuwenhoek stiles vessels; I have seen them separate after many reiterated efforts of the moving bodies; I have seen them at first lengthen, then diminish, and at last totally disappear. I therefore think these tails should be considered as accidental parts, and not as essential to the bodies of these pretended animals. But what is most remarkable, Leeuwenhoek precisely says, in his letter to Lord Brouncker, that, besides these animals that had tails, there were also smaller animals in this liquor, which had no other form than that of a globule. "His animalculis (caudatis scilicet) minora adhuc animalcula, quibus non nisi globuli figuram attribuere possum, permista erant." This is the truth; but after Leeuwenhoek had advanced that these animals were the only efficient principle of generation, and that they were transformed into human figures, he

has only regarded those as animals which had tails; and as it was consistent for animals that were transformed into human figures, to have a constant form, he never afterwards mentions those smaller animalcules without tails; and I was greatly surprised, on comparing the copy of this letter with that he published twenty years after, in his 3d volume, where, instead of the above words, the following are found: "Animalculis hisce permistæ jacebant aliæ minutiores particulæ, quibus non aliam quam globulorum seu sphæricam figuram assignare queo;" which is quite different. A particle of matter to which he attributes no motion, is very different from an animalcule: and it is astonishing that Leeuwenhoek, in copying his own works, has altered this essential article. What he adds immediately after likewise merits attention: he says, that by the desire of Mr. Oldenburg he had examined this liquor three or four years before, when he took these animalcules for globules; that is, there are times when these pretended animalcules are no more than globules, without any remarkable motion, and others when they move with great activity; sometimes they have tails, and at others they have none. Speaking in general of spermatic animals he

says,

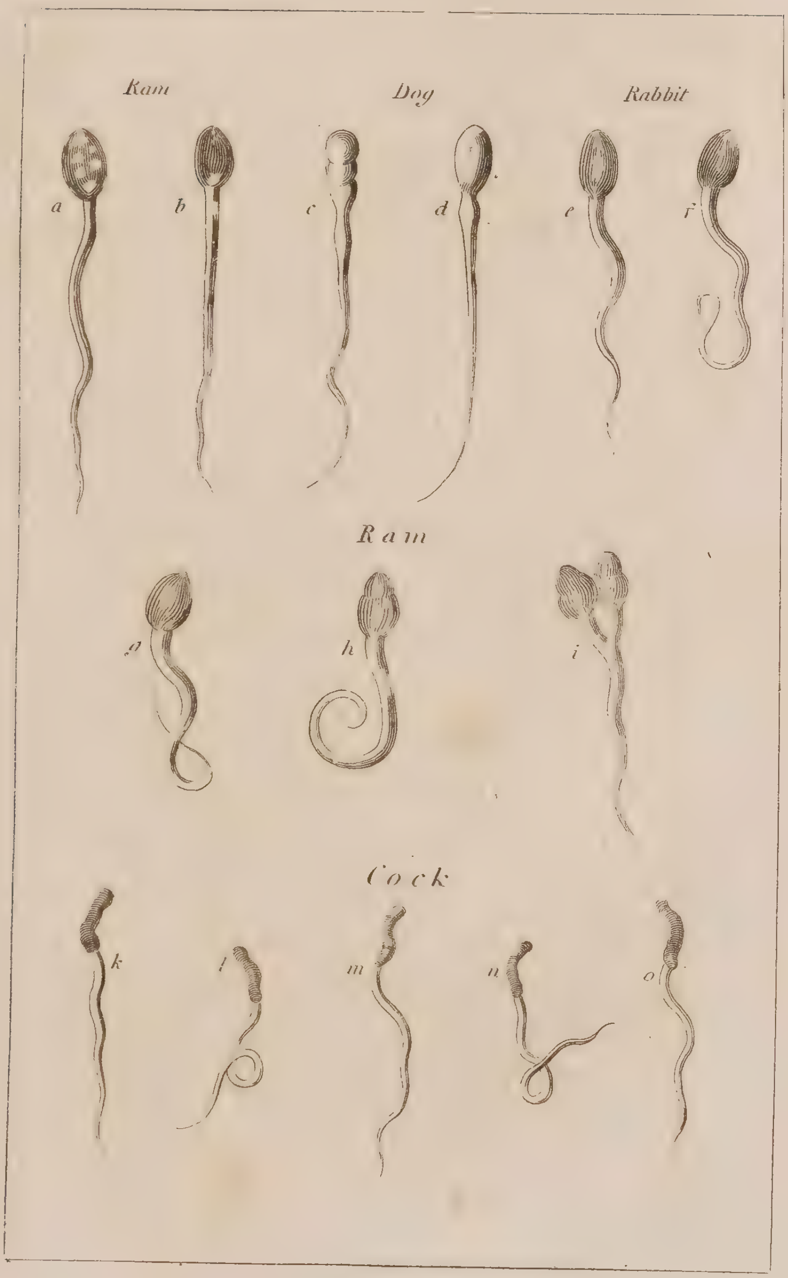
says, "Ex hisce meis observationibus cogitare cœpi, quamvis antehac de animalculis in seminibus masculinis agens, scripserim me in illis caudas non detexisse, fieri tamen posse ut illa animalcula æque caudis fuerint instructa ac nunc comperi de animalculis in gallorum gallinaceorum semine masculino;" another proof that he has often seen spermatic animals of all kinds without tails.

In the second place we must remark, that the filaments which are seen in the seminal liquor before it is liquefied were discovered by Leeuwenhoek, and that in his first observations, before he had made any hypothesis on spermatic animals, he considered these filaments as veins, nerves, and arteries; and firmly believed all the parts and vessels of the human body might clearly be seen in the seminal liquor. This opinion he persisted in, in defiance of the representations which Oldenburg made to him on this subject from the Royal Society: but as soon as he thought of transforming these pretended spermatic animals into men, he no longer mentioned these vessels; and instead of looking on them as nerves, arteries, and veins, of the human body already formed in the seed; he did not even attribute to them the functions they

really possess, the producing of these moving bodies: and he says, vol. 1. p. 7, "Quid fiet de omnibus illis particulis seu corpusculis præter illa animalcula semini virili hominum inhærentibus? Olim & priusquam hæc scriberem, in ea sententia fui, prædictas strias vel vasa ex testiculis principium secum ducere, &c." And in another part he says, that if he had formerly written any thing on the subject of these vessels found in the seed, we must pay no attention to it.

We shall observe in the third place, that if we compare the figures *a*, *b*, *c*, *d*, (PLATE III.) copied from the Philosophical Transactions, with those which Leeuwenhoek had engraved many years after, (PLATE IV.) we shall find considerable difference, especially in the figures of the dead animals, of a rabbit and in those of a dog, (which plate we have also copied for the satisfaction of our readers) from all which we may conclude, that Leeuwenhoek has not always observed objects entirely alive: that the moving bodies, which he looked upon as animals, appeared to him under different forms; and that he has varied in his assertions, with a view of making the species of men and animals perfectly consistent; he has not only varied in the

PLATE IV.



the basis of these experiments, but even in the manner of making them, for he expressly says, that he always diluted the liquor with water, in order to separate, and to give more motion to these animalcules: nevertheless, in his letter to Lord Brouncker, he says, that having mingled an equal quantity of rain water with the seminal liquor of a dog, in which he had before perceived an infinity of living animalcules, yet the mixing of this water killed them. The first experiment of Leeuwenhoek's therefore was made, like mine, without any mixture; and it even seems, that he was not of opinion to mix any water with the liquor till a long time after; because he thought he had discovered, by his first essay, that water caused the death of the animalculæ; which however is not the fact. I think that the mixture of the water only dissolves the filaments very suddenly; for I have seen but very few filaments in all the experiments I have made after mixing the water with the seminal liquor.

As soon as Leeuwenhoek was persuaded that spermatic animals were transformed into men, and other animals, he imagined he saw two sorts in the seminal liquor of every animal, the one male, and the other female; and this difference, according to him, served not only for the ge-

neration of themselves, but for the production of males and females, which was very difficult to conceive by a simple transformation. He speaks of the male and female animalcule, in his letter printed in the Philosophical Transactions, No. 145, and in many parts of his works,* but he does not describe the difference of these male and female animalcules, and which in fact never existed but in his own imagination.

The famous Boerhaave having asked Leeuwenhoek, if he had not observed in spermatic animals different degrees of growth and size? Leeuwenhoek answered, that having dissected a rabbit, he observed in the semen an infinite number of living animals. "Incredibilem, says he, viventium animalculorum, numerum conspexerunt, cum hæc animalcula scypho imposita vitreo & illic emortua, in rariores ordines disparassent, & per continuos aliquot dies sæpius visu examinassem, quædam ad justam magnitudinem nondum excrevisse adverti. Ad hæc quasdam observavi particulas perexiles & oblongas, alias aliis majores, &, quantum oculis apparebat, cauda destitutas; quas quidem particulas non nisi animalcula esse credidi, quæ ad

justam

* See vol. I. page 163, and vol. III. page 101, of his works.

justam magnitudinem non excrevissent."* Here then are animalcules of different sizes, some with tails and others without, which much better agrees with my experiments, than with Leeuwenhoek's own system. We differ only in one particular; he says, that those without tails were young animalculæ, which were not arrived at their full growth; while I, on the contrary, have seen these pretended animals quit the filaments with tails or threads, and afterwards lose them by degrees.

In the same letter to Boerhaave, he says, in the semen of a ram, he perceived animalcules following each other in swarms like a flock of sheep. "A tribus circiter annis testes arietis, adhuc calentes, ad ædes meas deferri curaveram, cum igitur materiam ex epididymibus eductam, ope microscopii contemplarer, non sine ingenti voluptate advertebam animalcula omnia, quotquot innatabant semini masculino, eundem natando cursum tenere, ita nimirum ut quo itinere priora prinatarent eodem posteriora subsequerentur, adeo ut hisce animalculis quasis sit ingenitum, quod oves factitare videmus, scilicet ut precedentium vestigiis grex universus incedat." This observation, which Leeuwenhoek

* See vol. IV. pages 280 and 281.

Leeuwenhoek made in 1713, and which he looks upon as singular and novel, proves to me, that he had never examined the seminal liquors of animals with attention, at least sufficient to give very exact descriptions of them. Leeuwenhoek was sixty-one years old in 1713, had made microscopical observations for more than forty-five years, had published the discovery of spermatic animals for about thirty-six years, and then, for the first time, saw in the seminal liquor of a ram, what is seen in all seminal liquors, and what I have described in Experiment IX. in the seed of a man; Experiment XII. in the seed of a dog; and in Experiment XXIX. in that of a bitch. It is not necessary to suppose the spermatic animals of the ram are endowed with instinct, to explain the floating of these animals, in flocks like sheep, since those of a man, dog, or bitch, does the same; and which motion depends solely on particular circumstances, whose principle is, that all the fluid matter of the seed is on one side, while the thick matter is on the other; for then all the bodies in motion will be disengaged from the mucilage, and follow the same road into the most fluid part of the liquor.

In

In another letter, written the same year, to Boerhaave, he relates some further observations he made on rams, and says, that he has seen, in the *vasa deferentia*, flocks of animals which float all on one side, and others which go in a contrary direction; and he adds, "Neque illud in unica epididymum parte, sed & in aliis quas præcideram partibus, observavi. Ad hæc, in quadam parastatarum resecta portione complura vidi animalcula, quæ necdum in justam magnitudinem adoleverant, nam et corpuscula illis exiliora & caudæ triplo breviores erant quam adultis. Ad hæc, caudas non habebant desinentes in mucronem, quales tamen adultis esse passim comperio. Præterea in quandam parastatarum portionem incidi, animalculis quantum discernere potui, destitutam, tantum illi quædam perexiguæ inerant particulæ, partim longiores, partim breviores, sed altera sui extremitate crassiunculæ; istas particulas in animalcula transituras esse non dubitabam." It is easy to see, by this passage, that Leeuwenhoek had seen, in this seminal liquor, what I found in all; that is to say, moving bodies of different sizes, figures, and motions; and which agrees much better with the idea of organic particles in motion than of that with real animals.

It appears, therefore, that Leeuwenhoek's observations are not contrary to mine, although he has drawn very different conclusions from them. I am persuaded that if any person would take the trouble of making the like experiments they would not have any difficulty in discovering from whence these differences proceed, and would find that I have advanced nothing which is not conformable to truth; and to enable the reader to decide thereon, I shall subjoin a few remarks.

The filaments I have spoken of are not always to be perceived in the seminal liquor of a man. To discover them it must be examined the moment it is taken from the body, and even then it will sometimes happen that there is not one to be seen. Sometimes the seminal liquor presents, especially when it is very thick, only large globules, which may be even distinguished with a common lens. By inspecting them with the microscope they appear like young oranges; they are very opaque, and a single one often fills up the whole table of the microscope. The first time I saw these globules I thought they were some foreign matters fallen into the liquor, but having examined different drops I discovered that the whole was composed

composed of these thick globules. I selected one of the roundest, and whose size was such that, its centre being in the middle of the table of the microscope, I could at the same time observe the whole circumference; at first it was absolutely opaque; a short time afterwards I perceived a bright luminous ring to form on its surface, which remained about half an hour, and then approached by degrees towards the centre, which became clear, and of different colours, while the remainder of the globule continued opaque. This light, which brightened in the centre of the globule, resembled those seen in the great air bubbles. The globule then began to get a little flat, and acquire a small degree of transparency. Having examined it more than three hours I perceived no more alteration, nor any appearance of motion, either internally or externally. I then imagined, that by mixing this liquor with water, these globules might be changed; in fact they did change, but they presented only a transparent and homogeneous liquor, wherein was nothing remarkable. I suffered the seminal liquor to liquefy of itself, and examined it at the end of six, twelve, and twenty-four hours, but saw nothing more than a fluid, with-

out the smallest resemblance of life or motion. I only relate this observation to shew that there are times when the common phenomena are not to be seen in the seminal liquor.

At times all the moving bodies appear to have tails, especially in the semen of a man and a dog; the motion is then the least brisk, and performed with difficulty. If this liquor is suffered to dry, the tails or threads are deprived of motion the first; the anterior extremity continues to vibrate for some time, and then all motion entirely ceases. These substances may be preserved in this state of dryness for a long time: if a small drop of water is mixed therewith, their figure changes, they are reduced into many globules, which sometimes appear to be in motion, as well by their approximation to each other, as by the trepidation and twirling round their centres.

These moving bodies in the seminal liquor of a man, dog, or bitch, so nearly resemble each other, as to admit of mistaking one for the other, especially if they are examined the moment the liquor is drawn from the animal. Those of the rabbit appear smaller and brisker; but these differences proceed more from the different states in which the liquor is at the time

of

of observation, than from the nature of the liquor itself, which ought to be different in different kinds of animals; for example, in that of a man I have seen streaks of thick filaments, (*fig.* 3.) and have perceived the moving bodies separate themselves from these filaments from whence they appeared to proceed; but I have never seen any thing like it in the semen of a dog; where, instead of filaments, or separated streaks, it is commonly a mucilage whose texture is more compact, and in which we with difficulty discern any filamentary parts; yet this mucilage gives birth to moving bodies like those in the semen of men.

The motions of these bodies remain a longer time in the liquor of a dog, than in that of a man; from which it is more easy to be certain of the alteration of form above mentioned. The moment the liquor issues from the body of the animal we perceive the animalcules to have tails; in twelve, twenty-four, or thirty-six hours after, we shall find they have lost those tails, and are then no more than ovals in motion, often much brisker than at first.

The moving bodies are always a little below the surface of the liquor. On the surface some large transparent air bubbles, which have

no

no motion, generally appear, though sometimes these bubbles stir and seem to have a progressive motion, but which is nothing more than the agitation of the air. Below the moving substances we often see others much smaller, and which only appear like globules, having no tails, but the greatest number of which are oftentimes in motion. I have also generally remarked, that in the infinite number of globules, in all those liquors, those which are very small, are commonly black, or darker than the rest; and that those which are extremely minute and transparent, have but little or no motion; they appear also to weigh specifically heavier, for they are always the deepest in the liquor.

CHAPTER XIII.

REFLECTIONS ON THE PRECEDING EXPERIMENTS.

BY the experiments we have just described, I was assured that females, as well as males, have a seminal liquor which contains moving substances; that these substances were not real animals, but only living organic particles; and that those particles exist, not only in the seminal liquors of the two sexes, but even in the flesh of animals, and in the germs of vegetables. To discover whether all the parts of animals, and all the germs of vegetables, contained living organic particles, I caused infusions of the

the flesh of different animals to be made, and of more than twenty kinds of seeds of different plants; and after they had infused four or five days, in phials closely stopt up, I had the satisfaction to see moving organic parts in them all; some appeared sooner, and others later; some preserved their motion for months together, while others were soon deprived of it; some directly produced large moving globules, that had the appearance of real animals, which changed their figures, separated, and became successively smaller: others produced only small globules, whose motions were very brisk; others produced filaments which lengthened and seemed to vegetate, swelled, and afterwards thousands of moving globules issued therefrom; but it is useless to detail my observations on the infusion of plants, since Mr. Needham has published so excellent a treatise on the subject. I read the preceding treatise to that able naturalist, and often reasoned with him on the subject, particularly on the probability that the germs of vegetables contained similar moving bodies to those in the seed of male and female animals. He thought those views sufficiently founded to deserve to be pursued; and therefore began

to

to make experiments on all parts of vegetables; and I must own that the ideas I gave him on this subject have reaped greater profit under his hands than they would have done from me. I could quote many examples, but shall confine myself to one, because I indicated the circumstance I am going to relate.

To determine whether the moving substances seen in the infusions of flesh were true animals, or only, as I supposed, moving organic particles, Mr. Needham imagined that he had only to examine some roasted meat, because if they were animals the fire must destroy them; and if not animals, they might still be found there as well as when the meat was raw; having therefore taken the jelly of veal, and other roasted meat, he infused them for several days in water, closely corked up in phials, and upon examination he found in every one of them a great quantity of moving substances. He shewed me some of these infusions, and among the rest that of the jelly of veal, in which there were moving substances, perfectly like those in the seminal liquor of a man, a dog, and a bitch, when they have no threads, or tails; and although we perceived them to change their figures, their motions so perfectly

 resembled

resembled those of an animal which swims, that whoever saw them, without being acquainted with what has been already mentioned, might certainly have taken them for real animals. I shall only add, that Mr. Needham assured himself, by a multiplicity of experiments, that all parts of vegetables contain moving organic particles, which confirms what I have said, and extends my theory on the composition of organized beings, and their reproduction.

All animals, both male and female, and all vegetables whatsoever, it is therefore evident are composed of living organic parts. These organic parts are in the greatest abundance in the seminal liquor of animals, and in seeds of vegetables. It is from the union of these organic parts returned from all parts of the animal or vegetable body, that reproduction is performed, and is always like the animal or vegetable in which it operates; because the union of these organic parts cannot be made but by the means of an internal mould, in which the form of an animal or vegetable is produced. It is in this also the essence of the unity and continuity of the species consists, and will so continue while the great Creator permits their existence.

But

But before I draw general conclusions from the system I am establishing, I must endeavour to remove some objections which might be made, and mention some other circumstances which will serve to place this matter in a better light.

It will be asked, why I deny those moving substances in the seminal liquors to be animals, since they have constantly been regarded as such by Leeuwenhoek, and every other naturalist, who has examined them? I may also be told, that living organic particles are not perfectly intelligible, if they are to be looked upon as animalculæ; and to suppose an animal is composed of a number of small animals, is nearly the same as saying that an organized being is composed of living organic particles. I shall therefore endeavour to answer these objections in a satisfactory manner.

It is certain that almost all naturalists agree in looking on the moving substances in seminal liquors as real animals; but it is no less certain, from my own observations, and those of Mr. Needham, on the seed of the calmar, that these moving substances are more simple and less organized beings than animals.

The word *animal*, in the acceptation we commonly receive it, represents a general idea formed of particular ideas drawn from particular animals. All general ideas include many different ones, which approach, or are more or less distant from each other, and consequently no general idea can either be exact or precise. The general idea which we form of an animal may be taken principally from the particular idea of a dog, a horse, and other beasts, which appear to us to act and move according to the impulse of their will, and which are besides composed of flesh and blood, seek after their food, have sexes, and the faculty of reproduction. The general idea, therefore, expressed by the word *animal*, must comprehend a number of particular ideas, not one of which constitutes the essence of the general idea, for there are animals which appear to have no reason, will, progressive motion, flesh nor blood, and which only appear to be a congealed substance: there are some which cannot seek their food, but only receive it from the element they live in: there are some which have no sensation, not even that of feeling, at least in any sensible degree: there are some have no sexes, or are both in one; there only belongs, therefore, to the

the animal a general idea of what is common also to the vegetable, that is, the faculty of reproduction.

The general idea then is formed from the whole taken together, which whole being composed of different parts, there is consequently between these parts degrees and links. An insect, in this sense, is something less of an animal than a dog; an oyster still less than an insect; a sea-nettle, or a fresh-water polypus, still less than an oyster; and as nature acts by insensible links, we may find beings which are still less animated than a sea-nettle, or a polypus. Our general ideas are only artificial methods to collect a quantity of objects in the same point of view; and they have, like the artificial methods we shall speak of, the defect of never being able to comprehend the whole. They are likewise opposite to the walk of nature, which is uniform, insensible, and always particular, insomuch that by our endeavouring to comprehend too great a number of particular ideas in one single word, we have no longer a clear idea of what that word conveys; because, the word being received, we imagine that it is a line drawn between the productions of nature; that all above this line is *animal*, and

and all below it *vegetable;* another word, as general as the first, and which is used as a line of separation between organized bodies and inanimate matter. But as we have already said, these lines of separation do not exist in nature; there are beings which are neither animals, vegetables, nor minerals, and which we in vain might attempt to arrange with either. For example, when Mr. Trembly first observed the polypus, he employed a considerable time before he could determine whether it was an animal or a plant: and possibly from this reason that it is perhaps neither one nor the other, and all that can be said is, that it approaches nearest to an animal; and as we suppose every living thing must be either an animal or a plant, we do not credit the existence of an organized being, that cannot be referred to one of those general names; whereas there must, and in fact are, a great number of organized beings which are neither the one nor the other. The moving substances perceived in seminal liquors, in infusions of the flesh of animals, in seed, and other parts of plants, are all of this kind. We cannot call these animals, nor can we say they are vegetables, and certainly we can still less assert they are minerals.

7 We

We can therefore affirm, without fear of advancing too much, that the grand division of nature's productions into *Animals*, *Vegetables*, and *Minerals*, do not contain every material being; since there are some that exist which cannot be classed in this division. We have already observed, that nature passes by insensible links from the animal to the vegetable, but from the vegetable to the mineral the passage is quick, and the distance considerable; from whence the law of nature's passing by imperceptible degrees appears untrue. This made me suppose that by examining nature closely we shall discover intermediate organized beings, which without having the power of reproduction, like animals and vegetables, would nevertheless have a kind of life and motion; other beings which, without being either vegetables or animals, might possibly enter into the composition of both, and likewise other beings which would be only the assemblage of the organic molecules I have spoken of in the preceding chapters.

In the first class of these kind of beings eggs must be placed; those of hens, and other birds, are fastened to a common pedicle, and draw their nourishment and growth from the body

body of the animal, but when fastened to the ovary, they are not then real eggs, but only yellow globules which separate from the ovary as soon as they have attained a certain growth. Their internal organization is such that they derive nourishment from the lymph, the matrix of the hen, and by which they form the white membranes, and at last the shell. The egg therefore has a kind of life and organization, a growth, expansion, and a form which it assumes by its own powers. It does not live like an animal, nor vegetate like a plant, nor is possessed of the power of reproduction; nevertheless it grows, acts externally, and is organized. Must we not then look upon it as a being of a separate class, and which ought not to be ranked either with animal or mineral? for if it is pretended that the egg is only an animal production, destined for the nutriment of the chicken, and should be looked upon as a part of the hen; I answer, that the eggs, whether impregnated or not, will be always organized after the same mode; that impregnation only changes an almost invisible part; and that it attains its perfection and growth, as well externally as internally, whether

ther it contains the chicken or not, and that consequently it ought to be considered as a separate being.

What I have said will appear more clear, if we consider the formation and growth of the eggs of fish; when the female deposits them in the water they are only the outlines of eggs, which being separated from the body of the animal, attract and appropriate to themselves the particles which agree the best for their nourishment, and grow thus by intussusception. In the same manner as the hen's egg acquires the white and membranes in the matrix, wherein it floats, so the eggs of fish acquire their membranes and white in the water; and whether the male impregnates them, by emitting on these the liquor of its roe, or whether they remain unimpregnated, they do not the less attain their entire perfection. It appears to me, therefore, that the eggs should be considered as organized bodies, which being neither animals nor vegetables, are a genus apart.

A second class of beings, of the same kind, are the organized bodies found in the semen of all animals, and which, like those in the milt of a calmar, are rather natural machines

 than

than animals. These are properly the first assemblages which result from the organic molecules we have so much spoken of, and they are, perhaps, the parts which constitute the organized bodies of animals. They are found in the semen of all animals, because the semen is only the residue of the organic molecules that the animal takes in with its aliment, and which, as we have already observed, are those parts most analogous to the animal itself, and most organic; it is those particles which compose the matter of the semen, and consequently we must not be astonished to find organized bodies therein.

To be perfectly convinced that these organized bodies are not real animals, we need only reflect on the preceding experiments. The moving bodies in the seminal liquor have been taken for animals, because they have a progressive motion, and are thought to have a tail; but if we consider, on one hand, the nature of this progressive motion, which finishes in a very short time without ever renewing its motion; and on the other, the nature of these tails, which are only threads which the moving bodies draw after them, we shall begin to hesitate; for an animal goes

sometimes

sometimes slow, sometimes fast, and sometimes remains in a state of rest; these moving bodies, on the contrary, always continue the same motion, and I have never seen them stop and renew their movement again. I ask, whether this kind of continued motion, without any rest, is common to animals, and if that ought not to make us doubt these moving bodies being real animals? An animal of any kind must also have a constant form and distinct limbs; but these moving bodies vary, and change their forms every moment, have no distinct limbs, and their tails appear as a part which does not belong to the individual. Can we then imagine these bodies to be real animals? In seminal liquors filaments are seen which lengthen and appear to vegetate; after which they swell and produce moving bodies. These filaments may be kinds of vegetables, but the moving bodies which spring from them cannot be animals, for a vegetable has never yet been seen to produce an animal. These moving bodies are found in all vegetable and animal substances; they are not produced by the modes of generation, they have no uniformity of species, and therefore can neither be animals nor vegetables. They are to be

met with in the flesh of animals, and in the substance of vegetables, but are most numerous in their seeds; is it not therefore natural to regard them as living organic particles which compose the animal or vegetable; as particles which having motion and a kind of life, ought, by their union, to produce moving and living beings, and so form animals and vegetables?

But in order to leave this matter as little in doubt as possible, let us examine other substances. Can it be said, the active machines which Mr. Needham perceived in the milt of the calmar were animals? Can it be thought that eggs, which are active machines of another kind, are also animals? If we turn our eyes to the representation of almost all the moving bodies Leeuwenhoek saw in different matters, shall we not be convinced, even at the first inspection, that those bodies are not animals, since not one of them has any limbs, but are all either globular or oval? If we afterwards examine what this celebrated naturalist says, when he describes the motion of these pretended animals, we can no longer doubt of his being in an error when he considered them as such; and we shall be still more and more confirmed that they are only moving organic particles by the following

 examples;

examples: Leeuwenhoek gives* the figure of the moving bodies which he observed in the liquor of a male frog. This figure only represents a slender body, long, and pointed at one of its extremities; and of this he says, "Uno tempore caput (thus he calls the thickest extremity of this moving body) crassius mihi apparebat alio; plerumque agnoscebam animalculum haud ulterius quam a capite ad medium corpus, ob caudæ tenuitatem, & cum idem animalculum paulo vehementius moveretur (quod tamen tarde fiebat) quasi volumine quodam circa caput ferebatur. Corpus fere carebat motu; cauda tamen in tres quatuorve flexus volvebatur." This then is the change of form which I mentioned to have seen, the mucilage from which the moving bodies use all their efforts to be disengaged, the slowness of their motion before they are disengaged; and the animal, according to Leeuwenhoek, one part of which is in motion, and the other dead: for he afterwards says, "Movebant posteriorem solum partem, quæ ultima, morti vicinia esse judicabam." All this does not agree with an animal, but with what I have spoken of; excepting that I never saw the tail move

* Vol. I. p. 51.

move but by the agitation of the body. He afterwards says, speaking of the seminal liquor of a cod, "Non est putandum omnia animalcula in semine aselli contenta uno eodemque tempore vivere, sed illa potius tantum vivere quæ exitui seu partui viciniora sunt, quæ & copiosiori humido innatant præ reliquis vita carentibus, adhuc in crassa materia, quam humor eorum efficit, jacentibus."

If these are animals, why have they not all life? why are they in the most fluid part of the liquor alive, while those in the thickest are not so? Leeuwenhoek did not perceive that the thick matter, the origin of which he attributes to the humour of the animalculæ, is nothing but a mucilaginous matter which produces them. By diluting this mucilage with water, he would have given life to the whole of them. Even this mucilage is oftentimes only a mass of those bodies which are set in motion on being separated; and consequently this thick matter, instead of being a humour, produced by the animalcules, is only the substance of the animals themselves, or rather, as we have already observed, the matter from which they originate. Speaking of the seed of a cock, Leeuwenhoek says, in his letter

ter to Grew, "Contemplando materiam (seminalem) animadverti ibidem tantam abundantiam viventium animalium, ut ea stuperem; forma seu externa figura sua nostrates anguillas fluviatiles referebant, vehementissima agitatione movebantur; quibus tamen substrati videbantur multi & admodum exiles globuli, item multæ plan-ovales figuræ, quibus etiam vita posset attribui, & quidem propter earundem commotiones; sed existimabam omnes hasce commotiones & agitationes provenire ab animalcules, sicque etiam res se habebat; attamen ego non opinione solum, sed etiam ad veritatem mihi persuadeo has particulas planam & ovalem figuram habentes, esse quædam animalcula inter se ordine suo disposita & mixta vitaque adhuc carentia." Here we see in the same seminal liquor animalcules of different forms; and I am convinced, by my own experiments, that if Leeuwenhoek had closely observed these oval substances, he would have discovered that they moved by their own powers, and that consequently they were as much alive as the rest. This change perfectly coincides with what I have said, that they are organic particles which take different forms, and not constant species of animals; for in the present

case,

case, if the bodies, which have the figure of an eel, are true spermatic animalcules, each destined to become a cock, which supposes a very perfect organization, and a very constant form, what will those be which have an oval figure, and what end do they answer? He says indeed afterwards, that these ovals may be conceived to be the same animals, by supposing their bodies to be twisted in a spiral form; but then how shall we conceive that an animal, whose body is constrained, can move without being extended? I maintain, therefore, that these oval substances are no other than the organic particles separated from their threads, and that the eels were the separated parts which dragged those threads after them, as I have many times perceived in other seminal liquors.

Leeuwenhoek, who imagined all these moving bodies were animals, and established a system thereon: who also pretended, that spermatic animals must become men and animals, now suspected they were only natural machines, or organic particles in motion: for he does not doubt these spermatic animals contained the great animal in miniature, he says, "Progeneratio animalis ex animalculo in seminibus masculinis

masculinis omni exceptione major est; nam etiamsi in animalculo ex semine masculo unde ortum est, figuram animalis conspicere nequeamus, attamen satis superque certi esse possumus figuram animalis ex qua animal ortum est, in animalculo quod in semine masculo reperitur, conclusam jacere sive esse; & quanquam mihi sæpius conspectis animalculis in semine masculo animalis, imaginatus fuerim me posse dicere, en ibi caput, en ibi humeros, en ibi femora; attamen eum ne minima quidem certitudine de iis judicium ferre potuerim, hujusque certi quid statuere supersedeo, donec tale animal, cujus semina mascula tam magna erunt, ut in iis figuram creaturæ ex qua provenit, agnoscere queam, invenire secunda nobis concedat fortuna." This fortunate chance, which Leeuwenhoek desires, presented itself to Mr. Needham. Every part of the spermatic animals of the calmar are easy to be seen without a microscope; but they are not young calmars, as Leeuwenhoek thinks, nor even animated, although they are in motion, but only machines which must be regarded as the first produce of the union of organic particles.

Although Leeuwenhoek had not such an opportunity of undeceiving himself, he nevertheless had another phenomena which ought to have had that effect; for example, he had remarked that the spermatic animals of a dog often change their figures, especially when the liquor was on the point of evaporating; that these pretended animals had a hole in the head when they were dead, and that this hole did not appear when they were alive; he had seen that the part which he looked upon as the head was full and plump when it was alive, and flaccid and flat when dead. All this ought to have led him to doubt whether these moving bodies were real animals; and consider it as agreeing better with a machine, which empties itself like that of the calmar, than with a moving animal.

I have said that these moving bodies, these organic particles, do not move like animals, nor have an interval of rest. Leeuwenhoek has observed the same: "Quotiescunque, says he, animalcula in semine masculo animalium fuerim contemplatus, attamen illa se unquam ad quietem contulisse, me nunquam vidisse, mihi dicendum est, si modo sat fluidæ superesset materiæ.

teriæ in qua sese commode movere poterant; et eadem in continuo manent motu, & tempore quo ipsis moriendum appropinquante, motus magis magisque deficit, usquedum nullus prorsus motus in illis agnoscendus sit." It appears difficult to conceive that animals can exist, from the moment of their birth till that of their death, in a continual rapid motion without the least interval of rest; and I cannot possibly imagine how these animals in the semen of a dog, which Leeuwenhoek saw the seventh day in as rapid motion as they were when they were first taken from the body of the animal, preserved a motion during that time so exceedingly swift, that no animal has sufficient power to move in for an hour; especially if we consider the resistance which proceeds from the density and the tenacity of the liquor. This kind of continued motion, on the contrary, agrees with the organic particles, which, like artificial machines, produce their effects in a continual operation, and which stop when that effect is over.

Among the great number of Leeuwenhoek's experiments, he, without doubt, often perceived spermatic animals without tails; and he endeavours to explain this phenomena

by a supposition; for example, he says, speaking of the semen of a cod, "Ubi vero ad lactum accederem observationem, in iis partibus quas animalcula esse censebam neque vitam neque caudam dignoscere potui; cujus rei rationem esse existimabam, quod quamdiu animalcula natando loca sua perfecte mutare non possunt tam diu etiam cauda concinne circa corpus maneat ordinata, quodque ideo singula animalcula rotundum repræsentent corpusculorum."

It would have been better to have said, as it in fact is, that the spermatic animals of these fish have tails at certain times and none at others, than to suppose their tails twisted so exactly round their bodies as to give them the shape of a globule. But this must not lead us to think that Leeuwenhoek only attended to the moving bodies which he saw with tails, but rather that he did not describe the others, because, although they were in motion, he did not regard them as animals; and this is the cause that all the spermatic animals he has depicted resemble each other, and drawn with tails, since he only took them for real animals in that state; and that when he saw them under other forms, he thought them imperfect,

perfect, or rather that they were dead. On the whole it appears, by my experiments, that far from displaying their tails the more as they are in a more perfect condition of swimming, as Leeuwenhoek says, they, on the contrary, lose their tails in a gradual manner, till at last these tails, which are no more than foreign bodies of the animalcules, and which they drag after them, entirely disappear.

In another part Leeuwenhoek, speaking of the spermatic animals of man, says, "Aliquando etiam animadverti inter animalcula particulas quasdam minores & subrotundas; cum vero se ea aliquoties eo modo oculis meis exhibuerint, ut mihi imaginarer eas exiguis instructas esse caudis, cogitare cœpi annon hæ forte particulæ forent animalcula recens nata; certum enim mihi est ea etiam animalcula per generationem provenire, vel ex mole minuscula ad adultam procedere quantitatem: & quis sit annon ea animalcula, ubi moriuntur, aliorum animalculorum nutritioni atque augmini inserviant?" By this passage it appears that Leeuwenhoek had seen animals without tails in the seminal liquor of a man, and that he is obliged to suppose them to be just born, and not adult; but I have observed quite the contrary; for the moving

moving bodies are never larger than when they separate from the filaments, and begin to move. When they are entirely disengaged from the mucilage they become smaller, and continue decreasing as long as they remain in motion. With respect to the generation of these animals, which Leeuwenhoek speaks of as certain, I am persuaded no sign of generation has ever been discovered; all he says is advanced on mere suppositions, which it is easy to prove by his own observations; for example, he says that the milt of certain fish, as the cod, fills by degrees with seminal liquor, which after the fish has emitted, the milt dries up, leaving only a membrane destitute of any liquor. "Eo tempore, says he, quo ascellus major lactes suos emisit, rugæ illæ, seu tortiles lactium partes, usque adeo contrahuntur, ut nihil præter pelliculas seu membranæ esse videantur." How then does he understand that this dry membrane, in which there is no longer either seminal liquor or animalcules, can reproduce animals of the same kind the succeeding year? if there was a regular generation in these animals, there could not be this interruption, which in most fishes lasts for a whole year. To draw himself out of this difficulty, he says, "Necessario statuendum erit, ut ascellus major semen

semen suum emiserit, in lactibus etiamnum multum materiæ seminalis gignendis animalculis aptæ remansisse, ex qua materia plura oportet provenire animalcula seminalia quam anno proxime elapso emissa fuerant." This supposition, that there remains something in the seminal liquor in the milts to produce spermatic animals for the succeeding year, is absolutely contrary to observations, for the milt is in this interval only a thin and absolutely dry membrane. But what reply can be made to a still further opposition to this point, there being fish like the calmar, the seminal liquor of which is not only renewed every year, but even the reservoir which contains it? Can it be said, that there remains a seminal matter in the milt for the production of the animals for the succeeding year, when even the milt does not remain? it is therefore very certain that these pretended spermatic animals are not multiplied, like other animals, by the mode of generation; which alone is sufficient to make us presume, that those particles which move in the seminal liquors are not real animals. Thus Leeuwenhoek, who in the passage above quoted says, it is certain that spermatic animals multiply and propagate by generation, nevertheless owns, in another

 part,

part, that the manner in which these animals are produced is very obscure, and that he leaves to others the task of clearing up this matter. "Persuadebam mihi," says he, speaking of the spermatic animals of the dormouse, "hæcce animalcula ovibus prognasci, quia diversa in orbem jacentia & in semet convoluta videbam; sed unde, quæso, primam illorum originem derivabimus? in animo nostro concipiemus horum animalculorum semen jam procreatum esse in ipsa generatione, hocque semen tam diu in testiculis hominum hærere, usquedum ad annum ætatis decimum-quartum vel decimum-quintum aut sextum pervenerint, eademque animalcula tum demum vita donari vel in justam staturam excrevisse, illoque temporis articulo generandi maturitatem adesse! sed hæc lampada aliis trado." I do not think it necessary to make any remarks on what Leeuwenhoek says on this subject: he saw spermatic animals without tails, and round, in the seed of a dormouse; "in semet convoluta," says he, because he supposes that they should have tails, and instead of being certain, as he before had been, that the animals propagate by generation, he here seems convinced of the contrary. But when he had observed the generation of pucerons, and

and was assured* that they engendered without copulation, he caught the idea to explain the generation of spermatic animals. "Quemadmodum, says he, animalcula hæc quæ pediculorum antea nomine designavimus (the pucerons) dum adhuc in utero materno latent, jam prædita sunt materia seminali ex qua ejusdem generis proditura sunt animalcula, pari ratione cogitare licet animalculæ in seminibus masculinis ex animalium testiculis non migrare seu ejici quin post se relinquant minuta animalcula aut saltem materiam seminalem ex qua iterum alia ejusdem generis animalcula proventura sunt idque absque coitu; eadem ratione qua supradicta animalcula generari observavimus." This supposition gives no more satisfaction than the preceding: for we do not understand by this comparison of the generation of these animalcules with that of a puceron, why they are not found in the seminal liquor of a man, before he has attained the age of fourteen or fifteen years; nor do we know from whence they proceed, nor how they are renewed every year in fish, &c. and it appears, that whatever efforts Leeuwenhoek made to establish the generation of spermatic animals on some probability, it still remained

* See vol. II. page 409, and vol. III. page 271.

mained an entire obscurity, and would, perhaps, perpetually have remained so, if the preceding experiments had not evinced that they are not animals, but moving organic particles contained in the nutriment the animal receives, and which are found in great numbers in the seminal liquor, which is the most pure, and in the most organic extracts drawn from this nutriment.

Leeuwenhoek acknowledges that he had not always found animalcules in the seminal liquor of males; in that of the cock, for example, which he had often examined, he saw spermatic animals in the form of eels but once, and some years after he could not discover any under that form, but observed some with large heads and tails, which his designer could not perceive. He says also, that one season he could not find living animals in the seminal liquor of the cod. All these disappointments proceeded from his desire of finding tails to these animals; and although he perceived little bodies in motion, he did not consider them as animals, because they were without tails, notwithstanding it is under that form they are generally seen, either in seminal liquors, or infusions of animal or vegetable substances. He says, in

the same place, that he was never able to make his designer perceive the spermatic animalcules of a cod, which he had so often seen himself.—" Non solum, says he, ob eximiam eorum exilitatem, sed etiam quod eorum corpora adeo essent fragilia, ut corpuscula passim dirumperentur; unde factum fuit ut nonnisi raro, nec sine attentissima observatione, animadverterem particulas planas atque ovorum in morem longas, in quibus ex parte caudas dignoscere licebat; particulas has oviformes existimavi animalcula esse dirupta, quod particulæ hæ diruptæ quadruplo fere viderentur majores corporibus animalculorum vivorum." When an animal of any kind ceases to live, it does not then suddenly alter its form, and from being long, like a thread, becomes round like a ball; neither does it become four times larger after its death than it was before. Nothing that Leeuwenhoek says here agrees with the nature of animals; but, on the contrary, the whole corresponds with a kind of machine, which, like those of a calmar, empty themselves after having performed their functions. But let us pursue this observation; he says, he has seen the spermatic animals of the cod in different forms, " multa apparebant animalcula sphæ-

 ram

ram pellucidam representantia;" he has also seen them of different sizes, "hæc animalcula minori videbantur mole, quam ubi eadem antehac in tubo vitreo rotundo examinaveram."

There needs nothing more to shew that there are no constant and uniform species of these animalcules; and that consequently they are not animals, but only organic particles in motion, which, by their different combinations, take different forms and sizes. These organic moving particles are found in great quantities in the extract and residue of our nutriment. The matter which adheres to the teeth, and which in healthy people has the same smell as the seminal liquor, is only a residue of the food, and a great number of these pretended animals are also found there, some of which have tails, and resemble those in the seminal liquor. Mr. Baker had four different kinds of them engraved, and which were all of a cylindrical or oval make, or globules with and without tails. I am persuaded, after having strictly examined them, that not any of them are real animals, but are like those in the seed, only living organical parts of the nutriment which present themselves under different forms. Leeuwenhoek, who

who did not know how to account for these pretended animals in the matter which adhered to the teeth, supposed them to proceed from certain food they were previously in, as cheese, &c. but we find them among the teeth of those who do not eat cheese, as well as in those that do; besides, they have not the least resemblance to mites, nor the other animalcules seen in rotten cheese. In another place he says, these animals of the teeth may proceed from the cistern water that is drank, because he observed animals like them in dew and rain water, especially in that which stagnates upon lead and tiles; but with which we can prove there is not the least resemblance.

Most seminal liquors dilute of themselves, and liquefy when exposed to the air or a certain degree of cold; but they thicken when a moderate degree of heat is communicated to them. I have exposed some of these liquors to a very intense cold, as water on the point of freezing, but it did no injury to these supposed animals; they continued to move with the same swiftness, and as long as those which had not been so exposed, but those which had suffered but a little warmth soon ceased to move, because the liquor thickened. If the moving bodies

bodies were animals, they were of a complexion and temperament quite different from all others, to whom a gentle and moderate heat strengthens their powers and motions, which the cold stops and destroys.

Notwithstanding it may be thought I have dwelt too long upon this subject, I cannot conclude it without making one remark, from which some useful conclusions may be drawn. These pretended spermatic animals, which are only living organic particles of the nutriment, not only exist in the seminal liquors of the two sexes, and in the residue of the nutriment which adheres to the teeth, but also in the chyle and excrements. Leeuwenhoek having met with them in the excrements of frogs, and other animals, which he dissected, was at first very much surprised, and not able to conceive from whence these animals proceeded, so entirely like those he had observed in the seminal liquors, accuses himself of having, in dissecting the animal, opened the seminal vessels, and that the seed had by that means been mixed with the excrements. But having afterwards found them in the excrements of other animals, and even in his own, he no longer knew to what to attribute them. Leeuwenhoek,

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it is worthy remark, never met with them in his own excrements, but when they were liquid. Every time he was disordered and the stomach did not perform its functions, and was relaxed, he discovered these animalcules; but when the concoction of the food was well performed, and the excrement was hard, there was not a single one, although it was diluted with water. This seems perfectly to agree with all we have before advanced: for when the stomach and intestines perform their functions, the excrements are only the grosser parts of the nutriment; and all that is really nutritive and organic passes into the vessels which serve to nourish the animal; whereas if the stomach and intestines are not in a condition to comminute the food, then it passes with the inanimate parts, and we find the living organic molecules in the excrements; from whence it may be concluded, that those which are often lax must have less seminal liquor, and be less proper for generation, than those of a different habit of body.

In all I have said, I constantly supposed the female furnished a seminal liquor, which was as necessary to generation as that of the male. I have endeavoured to establish in Chap. I. that every

every organized body must contain living organic particles, and I have endeavoured to prove Chap. II. and III. that nutrition and reproduction operates by the same cause; that nutrition is made by the intimate penetration of these organic particles through each part of the body, and that reproduction operates by the superfluity of these same organic particles collected together from all parts of the body and deposited in proper reservoirs. I have explained in Chap. IV. how this theory must be understood in the generation of man and animals which have sexes. Females then being organized bodies like males, they must also have some reservoirs for the superfluity of organic particles returned from every part of their bodies. This superfluity cannot come there through any other form than that of a liquor, since it is an extract of all parts of the body; and this liquor is that to which I have given the name of the female semen.

This liquor is not, as Aristotle pretends, an infecund matter of itself, which enters neither as matter nor form into the business of generation, but as essentially prolific as that of the male, containing characteristic parts of the feminine sex, which the female alone can produce, the same as the male contains particles necessary

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to form the masculine organs; and each of them contains every other organic particle that can be looked on as common to both sexes; which causes that, by their mixture, the daughter may resemble her father, and the son his mother. This semen Hippocrates says, is composed of two liquors; the one strong, for the production of males; and the other weak, for the production of females. But this supposition is too extended; I do not see how it is to be conceived that a liquor, which is the extract of every part of the female body, should contain particles for the formation of the male organs.

This liquor must enter by some way into the matrix of animals which bear and nourish their fœtus within the body, and in others, as oviparous animals, it must be absorbed by the eggs, which may be looked upon as portable matrixes. Each of these matrixes contains a small drop of this prolific liquor of the female, in the part that is called the *cicatrice*. When there has been no communication with the male, this prolific drop collects under the form of a small mole, or mass, as Malpighius observes; but when impregnated by that of the male, it produces a fœtus which receives its nutriment from the juices of the egg.

 Eggs,

Eggs, instead of being parts generally found in every female, are therefore only instruments made use of by Nature to serve as the matrix in females which are deprived of that organ. Instead also of being active and essential to the first fecundation, they only serve as passive and accidental parts for the nutrition of the fœtus already formed by the mixture of the liquor of the two sexes in a particular part of this matrix. Instead also of being existing bodies, inclosed, *ad infinitum*, one within the other, eggs, on the contrary, are bodies formed from the superfluity of a more gross and less organic part of the food, than that which produces the seminal and prolific liquor; and are in oviparous females something equivalent, not only to the matrix, but even to the menstrua in the viviparous.

We should be perfectly convinced, that eggs are only destined by Nature to serve as a matrix in animals who have not that viscera, by those females producing eggs independant of the male. In the same manner as the matrix exists in viviparous animals, as a part appertaining to the female sex, hens, which have no matrix, have eggs in their room, which are successively produced of themselves, and necessarily exist in the female independantly of

any

any communication with the male. To pretend that the fœtus is pre-existing in the eggs, and that these eggs are contained, *ad infinitum*, within each other, is nearly the same as to pretend that the fœtus is pre-existing in the matrix, and that the matrix of the first female inclosed all that ever were or will be produced.

Anatomists have taken the word *egg* in several acceptations and meanings. When Harvey took for his motto, *Omnia ex ovo*, he understood by the word egg, as applied to viviparous animals, the membrane which includes the fœtus and all its appendages: he thought, he perceived this egg, or membrane, form immediately after the copulation of the male and the female. But this egg does not proceed from the ovium of the female; and he has even maintained, that he did not remark the least alteration in this testicle, &c. We perceive there is here nothing like what is commonly understood by the word egg unless the figure of the bag may be supposed to have some resemblance thereto. Harvey, who dissected so many viviparous females, did not, he says, ever perceive any alteration in the ovaria; he looked on them even as small glands, perfectly useless to generation,* although

* See Harvey Exercit. 64 and 65.

though they undergo very remarkable changes and alterations in them, since we may perceive in cows the glandular bodies grow from the size of a millet seed to that of a cherry. This great anatomist was led into this error by the smallness of the glandular bodies in the species of deer, to which he principally paid his attention. C. Peyerus, who also made many experiments on them, says, "Exigui quidem sunt damarum testiculi, sed post coitum fœcundum, in alterutro eorum, papilla, sive tuberculum fibrosum, semper succrescit; scrofis autem prægnantibus tanta accidit testiculorum mutatio, ut mediocrem quoque attentionem fugere nequeat."* This author imagines, with some reason, that the minuteness of the testicles of does, is the cause of Harvey's not having remarked the alterations; but he is wrong in advancing that the alterations he had remarked, and which had escaped Harvey's notice, did not happen till after impregnation.

It appears that Harvey was deceived in many other essential points; he asserts, that the seed of the male does not enter into the matrix of the female, and even that it cannot; yet Verheyen found a great quantity of the male seed in the matrix

* Vide Conradi Peyeri Merycologia.

matrix of a cow, which he dissected six hours after copulation.* The celebrated Ruysch asserts, that having dissected a woman who had been caught in the act of adultery, and was assassinated, he found, not only in the cavity of the matrix, but also in the trunks, a quantity of the seminal liquor of the male.† Valisnieri affirms, that Fallopius and other anatomists had also discovered male seed in the matrix of many women. After the positive testimony of these great anatomists, there can remain no doubt but Harvey was deceived in this important point; especially when to these are added that of Leeuwenhoek, who found the male seed in the matrix of a great number of females of different species.

Harvey makes another error in speaking of an abortion in the second month, where the mass was as large as a pigeon's egg, but without any fœtus regularly formed; whereas, it is maintained by Ruysch, and many other anatomists, that the fœtus is perceptible, even to the naked eye, in the first month. The History of the Academy mentions a fœtus, that was completely formed in twenty-one days after impregnation. If to these authorities we add that of Malpighius,

* See Verheyen Sup. Anat. Tra. v. cap. iii.

† See Ruysch, Thes. Anat. p. 90, tab. vi, fig. 1.

Malpighius, who perceived the chicken in the cicatrice, immediately after the egg was laid by the hen, we cannot doubt, but that the fœtus is formed immediately after copulation; consequently, we must not pay any credit to what Harvey says on the parts encreasing one after the other by juxta-position, since they are all existent from the first, and gradually expand until the whole is complete.

De Graaf took the acceptation of the word egg in a quite different light to Harvey: he insists that the testicles of women were true ovaries, and contain eggs like those of oviparous animals, only that they are much smaller, do not quit the body, and are never detached till after impregnation, when they descend from the ovary into the horns of the matrix. The experiments of De Graaf have contributed most to establish the existence of these pretended eggs, which yet is not at all founded; for this famous anatomist is deceived, first, by mistaking the vesicles of the ovarium for eggs, whereas they are inseparable from it, form parts of its substance, and are filled with a kind of lymph. Secondly, he is also deceived when he considers the glandular bodies to be the covering of those eggs, or vesicles; for it is certain, by Malpighius's,

hius's, Valisnieri's, and my own observations, that the glandular bodies neither surround nor contain one of those vesicles. Thirdly, he is deceived still more when he supposes the glandular body is never formed till after fecundation; as they are invariably found in every female who has attained the age of puberty. Fourthly, he is no less deceived when he believes that the globules which he saw in the matrix, and which contained the fœtuses, were the same vesicles, or eggs, which had fallen from the ovarium, and which, he remarks, were become ten times smaller than they were in the ovary. This remark alone, one would imagine, should have made him perceive his error. Fifthly, he is wrong in saying that the glandular bodies are only the coverings of the fecundated eggs, and that the number of coverings, or empty follicles, always answer to the number of fœtuses. This assertion is entirely contrary to truth; for on the testicles of all females we find a greater number of glandular bodies, or cicatrices, than there are productions of fœtuses, and they are also found in those which have never brought forth. To this we may add, that neither he, Verheyen, nor any other person, have ever seen these eggs, much less these

pretended

pretended coverings, on which they have, notwithstanding, established their system.

Malpighius, who perceived the growth of the glandular bodies in the female testicles, was deceived when he thought he had seen the egg in their cavities, since they contain only liquor; nor indeed has any thing like an egg ever been discovered.

Valisnieri, who was not deceived in facts, has yet drawn false conclusions in asserting that, although neither himself, nor any anatomist in whom he could confide, ever found the egg in the cavity of the glandular body, yet it must there exist.

Let us, therefore, examine what may be fairly called the real discoveries of these naturalists. Graaf was the first who perceived there were alterations in the female testicles; and he had reason to affirm, they were parts essential and necessary to generation. Malpighius demonstrated that these alterations were occasioned by the glandular bodies which grew to perfect maturity, afterwards they become flaccid, obliterated, and left only a slight cicatrice remaining. Valisnieri has placed this discovery in a very clear light; he has shewn that these glandular bodies are found in the testicles of every female; that they are

are augmented considerably in the season of love, that they increase at the expence of the lymphatic vesicles of the testicles, and that at the time of their maturity they were hollow and filled with liquor. This, then, is all that can be reduced to truth on the subject of the pretended ovaries and eggs of viviparous animals. What must we conclude therefrom? Two things appear very evident; the one, that there does not exist any eggs in the female testicles; the other, that there exists a liquor in the vesicles of the testicle, and in the cavity of the glandular bodies. We have demonstrated by the preceding experiments, that this last liquor is the true seed of the female, since it contains, like that of the male, spermatic animals, or rather organic moving particles.

We must, therefore, now be assured, that females have, as well as males, a seminal liquor. After all that has been advanced, we cannot doubt but the seminal liquor is the superfluity of the organic nutriment, which is sent back from all parts of the body into the testicles and seminal vesicles of the males, and into the testicles and glandular bodies of females. This liquor, which issues by the nipple of the glandular bodies, continually sprinkles

the horns of the matrix, and may easily procure admission either by the suction of the membrane of these horns, or by the little opening which is at the upper extremity, and thus enter into the matrix; but in the supposition of these pretended eggs, which were ten or twenty times larger than the opening of the horns of the matrix, we cannot comprehend how they could enter therein.

The liquor emitted by females, when they are excited, and which, according to de Graaf, issues from the neck of the matrix, and the orifice of the urethra, may be a superabundant portion of the seminal liquor which continually distils from the glandular bodies on the trunks of the matrix. But, possibly, this liquor may be a secretion of another kind, and perfectly useless in generation. To decide this question observations with a microscope are requisite; but *all* experiments are not permitted even to philosophers. I can only say, that I am inclined to believe that the same spermatic animals would be met with in this liquor as in that of the glandular bodies. I can quote an Italian doctor on this subject, who made this observation with attention, and which is thus related by Valisnieri: "Aggiugne il lodato sig. Bono

"d'avergli

"d'avergli anco veduti (animali spermatici) in
"questa linfa o siero, diro cosi voluttuoso, che
"nel tempore dell' amorosa zuffa scappa dalle
"femine libidinose, senza che si potesse sospe-
"tare che fossero di que'del maschio, &c." If this circumstance is true, as I do not doubt, it is certain, that this liquor is the same as that found in the glandular bodies, and that, consequently, it is the true seminal liquor: and although anatomists have not discovered the communication between the vacuities of de Graaf and the testicles, that does not prevent it being once in the matrix, from issuing out by the vacuities about the exterior orifice of the urethra.

From hence we must conclude that the most abandoned women will be the least fruitful, because they emit that liquor which ought to remain in the matrix for the formation of the fœtus. Thus we see why common prostitutes seldom have children, and why women in hot countries, where they have stronger desires than in the cold, are much less fertile; but we shall have occasion to speak of this hereafter.

It is natural to think that the seminal liquor of the male or female would not be fertile but when it contains moving bodies; nevertheless

that is still a question, and I should be led to think, as there are different states of this liquor, that in which these organic particles are seen in motion is not absolutely necessary for the purpose of generation. The Italian physician, above quoted, never perceived spermatic animals in his semen till he had attained a middle age, although he was father of several children before, and continued to have them afterwards.

These spermatic bodies, which move, may be looked upon as the first assemblages of the organic molecules which proceed from every part of the body; when a quantity of them collect they may be perceived with the microscope; but if they collect only in small quantity the body which they form will be too minute to be perceived, and in this case we shall not be able to distinguish any in the seminal liquor. A very long continuance of observations would be necessary to determine what can be the cause of all the differences remarked in the states of this liquor.

I can assert, from having often tried it, that by infusing the seminal liquors in water closely corked, at the end of three or four days an infinite multitude of moving bodies will be found, although the seminal liquors had no motion on

being

being first taken from the body of the animal. Flesh, blood, chyle, urine, nay all animal or vegetable substances, contain organic particles, which move at the end of some days in an infusion of water; they appear to act and move nearly in the same manner, and though produced from different bodies are perfectly similar, without any of them having a power peculiar to themselves. If these bodies must absolutely be termed animals, it must be allowed they are so imperfect that they ought to be looked upon as the outlines of them, or rather as bodies simply composed of particles the most essential to the existence of an animal; for natural machines, such as those found in the roe of a calmar, although they put themselves in action at certain times, are certainly not animals, although they are organized, acting, and, as I may say, living beings.

If it is once allowed, that the productions of Nature follow in an uniform order, and advance by imperceptible degrees and links, we shall have no difficulty in conceiving there are organic bodies existing, which belong neither to animals, vegetables, nor minerals.

It is certain, however, that all animals and vegetables contain an infinity of organic living

molecules.

molecules. These molecules successively take different forms, and different degrees of motion and activity, according to different circumstances. They are in a much greater number in the seminal liquor of both sexes, and in the germs of plants, than in other parts of the animal or vegetable. There exists, then, a living substance in animals and vegetables, common to both, and which substance is necessary to their nutrition. An animal procures nutriment from an animal or vegetable substance, and the vegetable can likewise be nourished from an animal or vegetable in a decomposed state. This nutritive substance, common to both, is always living, always active, and produces an animal or vegetable, as it finds an internal mould or an analogous matrix, as we have explained in the first chapters; but when this active substance collects in great abundance, in those parts where it can unite, it forms in the animal body other living creatures, such as the tape-worm, ascarides, and worms, which are sometimes found in the veins, in the sinus of the brain, in the liver, &c. These kinds of animals do not owe their existence to the animals of the same species, and we may, therefore, suppose, they are produced by this or-

ganic matter when it is extravasated, or is too abundant for the lacteal vessels to absorb. We shall hereafter have occasion to examine more largely the nature of those worms, and many other animals which are formed in a similar manner.

When this organic matter, which may be looked on as an universal seed, is collected in any great quantity, as in the seminal liquors, and in the mucilaginous parts of the infusion of plants, its first effect is to vegetate, or rather to produce vegetating beings. These zoophytes swell, extend, ramify, and produce globules, ovals, and other small bodies, of different figures, which have all a kind of animal life, a progressive motion, which is often very swift, and sometimes very slow. These globules themselves decompose, change their figures, and become smaller; and in proportion as they diminish in size the rapidity of their motion augments.

I have sometimes thought that the venom of the viper, and other active poisons, even that of the bite of a mad dog, might possibly be this active matter too rarefied; but I have not as yet had time to make the experiments which I had projected on this matter, as well as on

drugs

drugs used in medicine; all that I can at present ascertain is, that all infusions of the most active drugs swarm with moving bodies, which form therein in much less time than in other substances.

Almost all microscopic animals are of the same nature as the organized bodies which move in the seminal liquor, in the infusions of vegetables and the flesh of animals; the eel-like bodies in flour, vinegar, and water, in which lead has been soaked, are beings of the same nature as the first, and have a like origin.

CHAPTER IX.

VARIETIES IN THE GENERATION OF ANIMALS.

THE matter which serves for the nutrition and reproduction of animals and vegetables is therefore the same; it is a productive and universal substance, composed of organic molecules, and whose union produces organized bodies. Nature always works on the same

same fund, which is inexhaustible, but the means she employs to stamp its value are different, and these differences, or general agreements, deserve attention, because it is from thence we must derive our reasons to account for exceptions and particular varieties.

In general large animals are less productive than small. The whale, elephant, rhinoceros, camel, horse, the human species, &c. only produce one, and very seldom two, at a birth; whereas small animals, as rats, herrings, insects, &c. produce a great number at a time. Does not this difference proceed from there being more food required to support a large body than to nourish a small one, and from hence the former has less superfluous organic particles, which would convert into semen, than the latter? It is certain that small animals eat more in proportion than large ones; but it is likewise probable that the prodigious multiplication of the small animals, as bees, flies, and other insects, may be attributed to their being endowed with very fine and slender limbs and organs, by which they are in a condition to chuse what is most substantial and organic in the vegetable or animal matters from whence they derive their nutriment. A

bee, who lives on the purest parts of flowers, certainly receives more organic particles in proportion than a horse who feeds on the grosser parts of vegetables, hay, &c. The horse produces but one at one time, whereas the bee will bring forth three thousand.

Oviparous animals are in general smaller than the viviparous, and produce also more at a birth. The duration of the fœtus in the matrix of viviparous animals likewise opposes their increase, nor can there be any new generation take place during gestation, or while they are suckling their young; whereas oviparous animals produce at the same time both matrix and fœtuses, which they cast out of the body, and are therefore almost always in a state of reproduction; and it is well known that by preventing a hen from setting, and largely feeding, the number of her eggs will be considerably increased. If hens cease to lay when they sit, it is because they have ceased to feed; and it is the fear lest their eggs should not produce which causes them not to quit their nests but once a day, and that for a very short time, during which they take a little nutriment, but not one-tenth part of what they take at other times.

Animals

Animals which produce but a small number at a time, acquire the chief part of their growth before they are fit for engendering, whereas those which multiply numerously generate before they have received half their growth. The human species, the horse, the ass, the goat, and the ram, are not able to engender until they have obtained nearly the whole of their growth. It is the same with pigeons and other birds, who lay but a few eggs; but those which produce in great numbers, as poultry, fish, &c. engender much sooner. A cock is capable of engendering at the age of three months, when he has not attained a third part of his growth; a fish, which at the end of twenty years will weigh thirty pounds, engenders in the first or second year, when perhaps it does not weigh half a pound. But exact observations on the growth and duration of the life of fish are still wanting: their age may be nearly known by examining the annual layers of their scales; but we are not certain how far that may extend. I have seen carp in the Comte de Maurepas' canals, at his castle at Pont Chartrain, which were said to be 150 years old, and they appeared as brisk and lively as the common carp. I will not

say, with Leeuwenhoek, that fish are immortal, or at least can never die with age; all must perish in time, that is, all which have a beginning, a birth, must arrive to an end, or death; but fish, living in an uniform element, and being sheltered from the vicissitudes and all the injuries of the air, must live a longer time in the same state than other animals, especially if these vicissitudes of the air be, as a great philosopher asserts, the principal causes of the destruction of living beings. But what must contribute to the long duration of their life is, that their bones are softer than those of other animals, and do not harden with age. The bones of fish lengthen, and grow thick without taking any more solidity; whereas the bones of other animals continually increase in hardness and density, until at length, being absolutely full, the motion of their fluid ceases, and death ensues. In their bones the repletion or obstruction, which is the cause of natural death, is formed by such slow and insensible degrees, that fish must require much time to arrive at what we call old age.

All quadrupeds covered with hair are viviparous; all those covered with scales oviparous. May we not then believe than in oviparous quadrupeds,

quadrupeds, a much less waste is made by transpiration, than the cloathing of scales retains; whereas in animals covered with hair this transpiration is more free and abundant? and is it not partly by this superabundance of nutriment, which cannot be carried off by transpiration, that those animals multiply so abundantly, and are enabled to go so long without food? All birds and all insects that fly are oviparous, excepting some kinds of flies which bring forth their young alive. These flies have no wings at their birth, but they shoot out and grow by degrees, and which they cannot use before they are of full growth. Scaly fish are likewise oviparous; as are all reptiles which have no legs, such as snakes and different kinds of serpents; they change their skins, which are composed of small scales. The viper is only a slight exception to the general rule, for it is not truly viviparous, as it produces eggs, from which the young are hatched; it is certain this is performed in the body of the mother, who instead of casting those eggs, like other oviparous animals, she retains and hatches them in her own body. The salamander, in which eggs and young ones are found at the same time, as observed by M. de Maupertuis,

Maupertuis, is an exception of the same kind in oviparous quadrupeds.

Most animals are perpetuated by copulation; yet many birds seem only strongly to compress the females; indeed the ostrich, crane, and some few others, are so well supplied as to leave intromission no ways equivocal. Male fish approach the female in the spawning time; they seem even to rub their bellies against each other, for the male often turns upon its back to meet the belly of the female; but the necessary part for copulation does not exist in them; and the male fish approaches the female only to emit the liquor in their milts on the eggs, which the female then deposits; and it seems rather to be attracted by the eggs than the female; for when she ceases throwing out the eggs, he instantly forsakes her, and with eagerness pursues the eggs, which the stream carries away, or that the wind disperses. Male fish may be seen to pass and repass every spot where eggs are deposited several times. It is certainly not for the love he bears the female that all these motions are made, because it is not to be presumed he always knows her; often being seen to emit his liquor on all eggs that he comes near,

and that often before he has met with the female to which they belonged.

There are therefore animals, distinguished by sexes, which have proper parts for copulation, and some which are deficient in them; others, as snails, have both, and the two sexes in the same individual; others, as vine-fretters, have no sex, and engender in themselves separately; although they couple together when they please, we cannot determine whether that is a conjunction of sexes; if it is so, we must suppose that Nature has included in this small individual more faculties for generation than in any other kind of animal, and that it not only has the power of reproducing distinctly, but also the means of multiplying by the communication of another individual.

But whatever difference takes place in generation, Nature, by a new production, prepares the body for it, and which, whether manifested outwardly, or concealed internally, always precedes generation. The ovaries of oviparous animals, and the testicles of female viviparous animals, before the season of impregnation, experience a considerable change. Oviparous animals produce eggs, which at first are attached to the ovaries, by degrees

they encrease in size, until they fall into the canal of the matrix, where they acquire their white membranes, and shell. This production has marks of the fecundity of the female, and without which generation cannot be performed: so in viviparous females there are always one or more glandular bodies on the testicles, which by degrees grow under the membrane that surrounds them; these glandular bodies enlarge and pierce, or rather impel and lift up the membrane of the testicle; when their maturity is complete, a small slit or several small holes appear at their extremities, by which the seminal liquor escapes, and falls into the matrix: these glandular bodies are new productions that precede generation, and without which there would not be any.

In males there is also a similar change which always precedes their capacity for generating. In oviparous animals a great quantity of liquor fills a considerable reservoir, and which reservoir itself is sometimes formed every year; as in the calmar and some other fish. The testicles of birds swell surprisingly just preceding their amorous season. In viviparous males the testicles also swell considerably in those who have

seasons,

seasons, and in general there is a swelling and an extension of the genital members in all species, which, although it be external, must be regarded as a new production necessarily preceding generation.

In the body of every animal, male or female, new productions are formed which precede generation; and when there is no real production there is always a swelling, and considerable extension in some of the parts. There are species in which this new production is not only manifest, but even the whole body seems to be renewed before generation can be performed; as is the case with insects whose various metamorphoses seem to be only for the purpose of generating; for the growth of the animal is completed before it is tranformed. It ceases from taking nutriment, has no organs for generation, no means of converting the nutritive particles, of which they abound, into eggs or seminal liquor, and therefore this superfluity unites and moulds itself at first into a form something like that of the original. The caterpillar becomes a butterfly, because, for these reasons, it is unable to produce small organized beings like itself; the organic particles, always active, take another form, by uniting, whose

whose figure answers in part, and even in essential constitution, to that of the caterpillar, but in which the organs of generation are developed, and may receive and transmit the organic particles of the nutriment which forms the eggs, and the individuals of the species. The individuals which proceed from the butterfly ought not to be butterflies, because the nutriment, from whence the organic particles proceed, was taken while in the form of caterpillars; the produce therefore must be similar, and not butterflies, which is only an occasional production of the superabundant nutriment; a method adapted by Nature to accomplish the purposes of generation in these species, as by the glandular bodies and milts in other animals.

When the superabundant quantity of organic nutriment is not great, as in man and most large animals, generation is not made till the growth of the animal is nearly complete, and then it is confined to the production of a small number of individuals. When these particles are more abundant, as in many kinds of birds, and in oviparous fishes, generation is completed before the animal has received its full growth, and their production of individuals is

is very numerous. When the quantity of particles is still greater, as in insects, it first forms a large organic body, which, though retaining the essential constitution of its original, differs in many parts, as the butterfly from the caterpillar, but shortly produces an astonishing number of young, similar in form to the animal which selected the nutriment. When the superabundance is greater still, and when at the same time the animal has the necessary organs for generation, as the vine-fretter, it immediately produces a generation in every individual, and afterwards a transformation, like other insects. The vine-fretter becomes a fly, but cannot produce any thing, because it is only the remainder of the organized particles which had not been made use of in the production of the young.

Almost every animal except man has stated times for generation. Spring is marked out for birds. Carp, and many kinds of fish, spawn in June and August. Barbel, and other kinds, in spring. Cats have three seasons, in January, May, and September. Roebucks, in December. Wolves and Foxes, in January. Horses, in summer. Stags, in September and October; and almost all insects generate in

autumn: these last seem to be totally exhausted by generation, and die a short time after. Other animals, though not exhausted, become extremely lean and very weak, and require a considerable time to repair the loss which is made of the organic substance. Others are exhausted still less, and are soon restored to an engendering state; while man is scarcely in the least affected; his loss is speedily repaired, and therefore may be said to be at all times in a state for propagation; all which depends solely on the particular construction of the animal organs. The grand limits Nature has placed in the mode of existence are equally conspicuous in the manner of receiving and digesting the food, in the manner of retaining it in, or excluding it from, the body, and in the means by which the organic molecules, necessary for reproduction, are extracted. In a word, we shall find throughout all nature, that all what can be, is.

The same difference exists in the time of female gestation; some, as mares, carry their young eleven or twelve months; others, as women, cows, &c. nine months; others, as foxes, wolves, &c. five months; bitches, nine weeks; cats, six weeks; rabbits, thirty-one

days. Most birds come out of the egg at the end of twenty-one days; though some, as canary birds, hatch in thirteen or fourteen days. The variety is as great here as in every thing else relative to animals. The largest animals which produce only few, are those which go the longest with young; this still more confirms what we have already said, that the quantity of organic food is in proportion less in large than in small animals; for it is from the superfluity of the mother's food that the fœtus derives what is necessary to the growth and expansion of its parts, and since this expansion demands much more time in large than in small animals, it is a proof that the quantity of matter which contributes is not so abundant in the first as in the last.

There is, therefore, an infinite variety in animals, with respect to the time and manner of gestation, engendering, and bringing forth; and this variety is found even in the causes of generation; for although the general principle of production is this organic matter common to all that lives or vegetates, the manner in which the union is made, must have infinite combinations, which must all proceed from the source of new productions. My experi-

ments clearly demonstrate, that there are no pre-existing germs, and at the same time prove that the generation of animals and vegetables is not equivocal; there are, perhaps, as many beings, either living or vegetating, which are produced by the fortuitous assemblage of organic molecules, as by a constant and successive generation. It is to those productions we should apply the axiom of the ancients, "Corruptio unius, generatio alterius." The corruption and composition of animals and vegetables produce an infinite number of organized bodies; some, as those of the calmar, form only kinds of machines, which, although very simple, are exceedingly active; others, as the spermatic animalcules, seem by their motion, to imitate animals; others imitate vegetables by their manner of growing or extending; there are others, as those of blighted corn, which may be made to live and die alternately, and as often as we please; there are still others, even in great quantities, which are at first kinds of vegetables, afterwards become species of animals, then return again to vegetables, and so on alternately. There is a great appearance, that the more we shall observe this race of organized beings, the more we shall discover varieties,

varieties, always so much the more singular as they are the more remote from our sight, and from the varieties of other animals that have already become known to us.

For example, spurred barley, which is produced by an alteration or decomposition of the organic substance of the grain, is composed of an infinity of little organized bodies, like to eels. By infusing the grain for ten or twelve hours in water, we find them to have a remarkable twirling, and a slight progressive motion; when almost dry, they cease to move, but by adding fresh water their motion returns. The same effects may be produced for months, or even years; insomuch that we can make these little machines act as often and as long as we please without destroying them, or their losing any of their power or activity. Their threads will sometimes open, like the filaments of semen, and produce moving globules; we may therefore suppose them to be of the same nature, only more fixed and solid.

Eels, in paste made with flour, have no other origin than the union of the organic particles of the most essential parts of the grain: the first which appear are certainly not produced by many others; yet, although they

they have not been engendered, they engender others. By cutting them with the point of a lancet, we may perceive small eels come from their bodies in great numbers; the body of the animal appears to be only a sheath or bag which contains a multitude of other little animals, which perhaps are themselves only sheaths of the same kind, in which the organic matter assimilates, and takes the form of eels.

There requires a great number of observations to be made to establish classes and races between such singular beings, which are at present so little known; there are some which may be regarded as real zoophytes, which vegetate, and at the same time appear to twirl and move like animals. There are some that at first appear to be animals, which afterwards join and form kinds of vegetables. A little attention to the decomposition of a grain of wheat infused in water will elucidate all I have asserted. I could add more examples, but I have related these only to point out the varieties there are in generation. There are certainly organized beings which we regard as animals, but which are not engendered by others of the same kind; there are

are some which are only a kind of machines, whose action is limited to a certain effect, and which can act but once in such a certain time, as those in the calmar; and there are others, as we have just remarked, which we can cause to act as long and as often as we please. There are vegetating beings which produce animated bodies, as the filaments of the human seed, from whence the active globules spring, and which move by their own powers. In the corruption, fermentation, or rather the decomposition of animal and vegetable substances, there are organized bodies which are real animals, and can propagate their like, although they have not been so produced. The limits of these varieties are perhaps still greater than we can imagine. We may extend our ideas, and exert every effort to reduce the effects of Nature to certain points, and class her productions to certain classes, yet an infinite number of links will always escape us.

CHAPTER X.

OF THE FORMATION OF THE FOETUS.

IT appears to be clearly ascertained by the experiments of Verheyen, who in one of them found the seed of a bull in the matrix of a cow; and by those of Ruysch, Fallopius, Leeuwenhoek, and many others, who perceived the male semen in the uterus of women, and numberless other animals, that the seminal liquor of the male enters by some means into the matrix of the female. It is probable, that in the time of copulation the orifice of the matrix opens to receive the seminal liquor, but if that is not the case, the active and prolific sub-

stance

stance of this liquor, may penetrate the membranes of the matrix; for the seminal liquor being, as we have proved, almost all composed of organic molecules, which are in great motion, and extremely minute, they may pass across the coat of the closest membranes, and penetrate those of the matrix with the greatest facility.

What proves that the active part of this liquor may not only pass through the pores of the matrix, but even penetrate its substance, is the sudden change that immediately takes place after conception. The menses are suppressed, the matrix becomes softer, swells, and appears inflamed. All these alterations can only happen by the action of an external cause; by the penetration of some part of the seminal liquor into the substance even of the matrix. This penetration not only operates on the external surface of the matrix, but on all the other parts of which this viscera is composed, like that penetration by which nutrition and expansion is produced.

We shall be easily persuaded that it is so, when we consider that the matrix, during the time of gestation, not only augments in bulk but also in quantity of matter, and that it has

 a kind

a kind of life or vegetation, which is continually increasing till the time of delivery; for if the matrix was only a pouch, a destined receptacle to receive the seed and contain the fœtus, it would extend and grow thin in proportion as the fœtus increased in size; but in reality the matrix not only extends in proportion as the fœtus grows larger, but receives at the same time a thickness and solidity. This augmentation is a real growth, like the expansion of the body in young animals, which can only be produced by the intimate penetration of the organic molecules analogous to the substance of the parts: and as this expansion of the matrix never happens but after impregnation, we cannot doubt its being produced by the liquor of the male, especially as the expansion takes place before the fœtus has sufficient bulk to dilate it.

It seems certain, by my experiments, that the female has a seminal liquor which commences to be formed in the testicles, and is completed in the glandular bodies: this liquor distills through the small holes, at the extremities of these bodies; and may, like that of the male, enter into the matrix in two different manners, either by these holes at the extremities,

ties, or through the membraneous coat of the matrix.

These seminal liquors are both extracts from all parts of the body, and in the mixture of them there is every thing necessary to form a certain number of males and females; and the more the animal abounds with this liquor, and the more that abounds with organic molecules, the greater is their number of young; as we have already remarked is the case with the small animals, and diminishes in the large.

But to pursue our subject with greater attention, we shall first examine the particular formation of the human fœtus, and afterwards return to the other animals. In the human species, as well as in large animals, the seminal liquors of the male and female do not contain a great abundance of organic molecules, and therefore seldom produce more than one at a time: the fœtus is a male, if the number of the organic molecules of the male predominates in the mixture, and a female if the contrary; and it resembles the father or the mother as they happen to abound in the mixture of the two liquors.

I conceive, therefore, that the seminal liquor of both are two matters equally active and

and necessary for generation; and this I think is sufficiently proved by my experiments, since I have seen the same moving bodies in the one as the other. I perceived that the liquor of the male enters into the matrix, where it meets with that of the female: that they have a perfect analogy, and are both not only composed of similar parts by their form, but also in their motions and actions; as we have remarked in CHAP. VI.

By the mixture of these two liquors I conceive the activity of the organic molecules of each is stopped, and that the actions of one counterbalance that of the other, insomuch that each particle ceasing to move, remains in the place most analogous to itself, and that they will naturally take the same position, and will dispose themselves in the same order they held in the animal body; those that came from the head will arrange themselves in the head of the fœtus, those of the back the same, and so of every other part; consequently they will form a small organized being, in every thing like the animal from which they are extracted.

It must be observed that this mixture of organic molecules of the two sexes contains si-

milar

milar and different particles; the similar ones are those which have been extracted from every part common to both sexes. The different particles are those which have been extracted from the parts whereby the sexes are distinguished; thus there is, in this mixture, double the number of organic molecules to form the head, or the heart, or such other parts common to both, whereas there are only what are requisite to form the parts of the sex. Now the similar particles may act upon each other without being disordered, and collect together as if they had been extracted from the same body; but the dissimilar parts cannot act on each other, nor unite together, because they have not any relation; hence these particles will preserve their nature without mixture, and will fix of themselves the first, without the need of being penetrated by the others. Thus the molecules proceeding from the sexual parts will be the first fixed, and all the rest which are common to both, will afterwards fix indiscriminately, whether they are those of the male or female, and form an organized being which, in its sexual parts, will perfectly resemble its father, if it is a male, and its mother if a female; but

which

which may resemble one another, or both, in all the other parts of the body.

It seems to me that if this was well understood, we shall in a great measure be enabled to answer the objections made to the sentiments of Aristotle, and which might also be advanced against this system. The question is, Why each individual, male and female, does not produce of itself an animal of its own sex? It must be acknowledged this question seems to carry weight with it; but having reflected a long time on this subject I think I have found an answer, and which I shall endeavour to explain.

It is certainly evident, from what we have said in the preceding chapters, and the experiments we have described, that reproduction is effected by the union of organic molecules returned from each part of the body of the animal, or vegetable, into one or many common reservoirs; and that they are the same molecules which serve for nutriment and expansion of the body. This appears to me to have been so clearly proved, that I apprehend no scruple can remain as to the foundation of the theory; but I admit there may be some reason to ask, Why each animal and vegetable does not produce its own

own likeness, since each individual returns from every part of its body, and collects in a common reservoir, all the organic molecules necessary for the formation of a small organized being? Why then is not this organized being formed? and why, in almost every animal, is a mixture of the liquors of the two sexes required to produce an animal? If I content myself with answering, that in almost all vegetables, and all kinds of animals which multiply by cutting, that it appears the design of Nature that each individual should increase its own species, and that we must regard as an exception to this rule, the use which is made of the sexes in other kind of animals; it may be said, that the exception is more universal than the rule itself. This difficulty will be very little weakened, if we were to say, that each individual perhaps would produce its like, if it had proper organs, and contained the necessary matter towards the nutriment of the embryo; because females have both this matter, and organs, and yet do not produce either male or female fœtus without the intervention of the male; which intervention of sexes in all animals is essential and absolutely necessary.

Although the testicles and seminal vesicles of a man, contain all the necessary molecules to

form a male, yet the local establishment and arrangement of these molecules cannot be made, because the effect of an union is prevented by the continual circulation of the seed both by absorption, and the action of the new organic molecules which constantly come into this reservoir from all parts of the body. The same circumstances taking place with the organic molecules of the female, is an evident reason why neither can produce of themselves, because when the seminal liquors of the male and female are mixed, they have more analogy to each other, than with the parts of the body of the female where the mixture is performed. By admitting of this explication, it may be asked, Why the common mode of generation in animals does not agree with it; for, upon that supposition, each individual would produce like snails, and impregnate each other, and each individual receiving the organic molecules the other furnished, the union would be made of itself, and by the sole power of the affinity of these molecules among themselves? I own, if it was by this cause alone the organic molecules could unite it would be natural to conclude, that the shortest mode to perform the reproduction of animals, would be to give to one individual

individual both sexes. But it is quite contrary to the general rule pursued by Nature, as this manner of generation is confined to snails, and a small number of other animals. This answer cannot be said to fully satisfy the question, as it merely supposes the male does not produce, as it cannot receive any thing from the female, and that having besides no proper viscera to contain and nourish the fœtus.

We may also suppose that the activity of the organic molecules, in the semen of one individual, has need of being counterbalanced by the activity or force of those of another individual, in order to fix and bring them into a kind of equilibrium, a state of rest highly necessary to the formation of the animal; and that this activity in the organic molecules can only be counterbalanced by there being a contrary action in those which come from the male, and those proceeding from the female; so that, in this sense, all living or vegetating beings must have two sexes, conjointly and separately, to produce their resemblances. But this answer is too general to be entirely clear; nevertheless, if we pay attention to all the phenomena, we shall find some explanation resulting therefrom. The mixture of those two liquors

produces not only a male or female fœtus, but also other organized bodies, which have a kind of growth or expansion. The placenta, membranes, &c. are produced at the same time as the fœtus. There are, therefore, in the seminal liquor of the male or female, or in the mixture of both, not only organic molecules necessary for the production of the fœtus, but also those which form the placenta and membranes. We know not from whence these molecules come, since there is no part of the body, either of the male or female, from which they could be sent back. From hence it seems it must be admitted, that the molecules of the seminal liquors of each, being alike active, form organized bodies every time they can fix, by acting mutually one on the other: that the particles employed to form a male, will be those of the masculine sex, which will fix the first, and form the sexual parts; and that those common to both sexes will then fix indifferently to form the rest of the body; and that the placenta and membranes are then formed from the superabundant particles, which have not been used to form the fœtus; if, as we suppose, the fœtus is a male, then there remains to form the placenta, and membranes, all the organic particles peculiar

to the feminine sex which have not been employed; and also all those of both which shall not have entered the composition of the fœtus, and which cannot be less than one half. So likewise, if the fœtus is a female, the same abundance will be left for the formation of the placenta, and membranes, and the whole effects be the same, excepting it will have the superfluity of the male, instead of that of the female.

But, it may be said, that in that case the placenta and membranes ought to become another fœtus, which would be a female, if the first was a male; and a male if the first was a female; for the first having consumed the organic molecules of the sexual parts of only one individual, and half those common to both, there remains all the molecules of the sexual parts of the other individual, and the other half of those common to both. To this I answer, that the first union of the organic molecules prevents a second, at least, under a similar form; that the fœtus, being the first formed, exercises an external power, which disorders the arrangement of the other organic molecules, prevents the formation of a second fœtus, and throws

throws them into a state from which the form of the placenta and membranes result.

We are assured by the experiments and observations we have made, that every living being contains a great quantity of living and active molecules. The life of the animal or vegetable appears to be only the result of all the young lives (if that expression is permitted me) of each of these active molecules, whose life is primitive, and appears impossible to be destroyed. We have found these living molecules in every living or vegetating being, and are assured, that they are alike necessary for nutrition, and consequently, for the reproduction of animals or vegetables. It is not, then, difficult to conceive, that a certain number of those molecules united should compose a living being. Each of these particles possessing animation, an assemblage of them must be endowed with life, and thus these living organic molecules, being common to all living beings, they necessarily form any particular animal or vegetable, according as they are arranged. Now, this arrangement absolutely depends on the form of the individuals which furnish those molecules. If they are furnished by an

animal,

animal, they will arrange under the form of an individual like to it, exactly as they were arranged when they served for the expansion of the animal itself; but must we not then suppose that this arrangement cannot be made either in animals or vegetables, but by the means of a kind of base, round which the molecules might unite to form the fœtus? Now, it is plain, this basis is furnished by particles peculiar to the different sexes, as I shall explain.

While the molecules of either sex remain by themselves, their action produces no effect, because they are without any opposition from any different kind of particles; but, when these molecules are mixed, then there are dissimilar parts, and those ser e for the base and point of rest to the other molecules, and fix their activity.

In this supposition that the organic molecules, which, in the mixture of the seminal liquors of the two individuals, represent the sexual parts of the male, can alone serve for a base to the organic molecules proceeding from every part of the female, and those peculiar to the female sex as a base to them which are extracted from the male, we might conclude, that

that the sexual part of the male infant is formed of the organic molecules of the father, and from those of the mother, for the rest of the body: and that, on the contrary, the female partakes of its mother only in sex, and takes the rest of its body from its father. Boys, therefore, ought, excepting the parts of the sex, to have a greater resemblance to their mother than to their father, and girls more to the father than to the mother; but this consequence is not, perhaps, conformable to experience.

By considering, under this point of view, generation by sexes, we should conclude it to be the most general mode of reproduction, as it is in fact. Beings, whose organization is the most complete, as animals, whose bodies compose a whole, which can neither be separated nor divided, and whose powers are concentered to one single point, can only reproduce by this mode; because they contain only particles which resemble each other, and whose union can only be made by different particles, furnished by another individual. Those where organization is less perfect, as that of vegetables, whose bodies may be divided and separated without being destroyed, can be reproduced

produced by other modes. First, because they contain dissimilar particles; secondly, because their forms not being so determinate and fixed as that of animals, the particles may supply the functions of each other, and change according to circumstances; as we see roots become branches, and shoot out leaves when exposed to the air, which causes that the vegetable particles obtain a local establishment, become fixed, and are enabled to multiply, by various modes.

It will be the same with animals, whose organization is less perfect, as the fresh water polypus, and others, which can reproduce by division of their parts. These organized beings are not so much a single animal, as a number united under one common covering, as trees are composed of a multiplicity of young trees. (see Chap. II.) Pucerons, which engender singly, also contain dissimilar particles, since, after producing their young they change into flies which do not produce at all. Snails communicate mutually these dissimilar particles, and afterwards they both produce. Thus, in all known matters of generation, we see that the requisite union of organic particles, can only be made by the mixture of different par-

ticles, which serve as a basis capable of fixing their motions.

If to the idea of the word *sex*, we give all the extent here supposed, we shall say, that sexes are found throughout all nature; for then sex will mean only the parts which furnish the organic particles, different from the common particles, and which must serve as a fixed point for their union. But, enough of reasoning on a question that can be at once resolved, by saying, that God having created sexes, it necessarily follows that animals should reproduce by their connection. In fact, we are not made, as I have formerly said, to give a reason for every *why*. We are not in a state of explaining *why* Nature, almost throughout her works, makes use of sexes for the reproduction of animals, or why sexes exist; we ought, therefore, to content ourselves with reasoning on what is, on things as they are, since we cannot go beyond, by forming suppositions which will remove us from the sphere we ought to contain ourselves in, and to which the small extent of our knowledge is limited.

Quitting, therefore, all doubtful conjectures, I shall rest on facts and observations. I find, that the reproduction of beings is formed in

many

many different manners; but, at the same time, I clearly perceive, that it is by the union of the organic particles sent back from every part of the individual, that the reproduction of vegetables and animals are effected. I am certain of the existence of these organic and active molecules in the seminal liquors of male and female animals and seed of vegetables; and cannot doubt but every species of reproduction is accomplished by the union of these organic molecules. Nor can I doubt, that in the generation of animals, and particularly in that of man, that the male and female particles mix in the formation of the fœtus, since we see infants which resemble both father and mother; and what confirms this conclusion is, that those parts, common to both sexes, mix promiscuously; whereas those never mix which represent the sexual parts. For we every day see children with eyes like the father, and the forehead and mouth like the mother; but we never find a like mixture of the sexual parts; it never happens that they have the testicles of the father, and the vagina of the mother, for even the fact of hermaphrodites is very doubtful.

In the parts of generation of the two sexes in the human species, there is so much resemblance, and so singular a conformity, that we might be inclined to think those which appear so different externally, are at bottom the same organs, only more or less developed; this was the opinion of the ancients, and M. Daubenton's ideas on this subject appear to me very ingenious.

The formation of the fœtus is, then, made by the union of the organic particles contained in the mixture of the seminal liquor of both sexes; this union produces the local establishment of the particles, which determines them to arrange themselves as they were in the individuals which furnished them; insomuch, that the molecules, which proceed from the head, cannot, by virtue of these laws, place themselves in the legs, or any other part of the fœtus. All these molecules must be in motion when they unite, and in a motion which must cause them to tend to a kind of centre, about which the union is made. This centre, or fixed point, which is necessary to the union of the molecules, and which, by its reaction and inertia, fixes the activity, and destroys the

the motion, is, probably, the first assemblage of the molecules which proceed from the sexual parts of the other individual; they must arrange under the form of an organized body which will not be another fœtus, for the reasons we have before given.*

On the whole, I conceive there are organic particles of the sexual parts, which serve as a fixed point, or a centre of union, around which all the other parts that form the embryo collect. I speak of it only as probable; but as they are the only particles which differ, I have thought it more natural to imagine, that it is around these different particles the union is formed than those which are common to both sexes.

We have before observed, that those who have imagined the heart was the first formed, are deceived: those who say it is the blood, are no less so. All is formed at the same time. If we only consult observation, the chicken is seen in the egg before it has been sat upon; we perceive the spine of the back and the head, and, at the same time, the appendages which form the placenta. I have opened a great number of eggs,

* In this, as in some other places, our author has gone into a diffuse repetition which we have considered unnecessary and therefore avoid.

eggs, before and after incubation; and I am convinced, by my sight, that the chicken exists entirely in the middle of the cicatrice, the moment it comes from the body of the hen. The heat, communicated to it by incubation, only expands the parts by setting the liquors in motion; but it is not possible to determine which parts of the fœtus are fixed in the instant of formation.

I have always said, that the organic molecules were fixed, and that their uniting was caused only by their loss of motion. This appears to me certain: for, if we separately examine the seminal liquor of the male and female, we shall see an infinity of small bodies in great motion, but being mixed, their motion is instantly suspended, and heat is necessary to renew their activity; for the chicken which exists in the centre of the cicatrice is without any motion before incubation; and even twenty-four hours after, when it begins to become perceptible with a microscope, there is not the least appearance of motion then, nor even the day following. During the first day it is only a small white mucilaginous mass, which is of a consistence on the second, and insensibly increases, but whose motion is very slow, and

does

does not at all resemble that of the organic particles which move rapidly in the seminal liquor. Besides, I have reason to say, that this motion of the organic molecules is absolutely destroyed; for if we keep an egg without exposing it to a degree of heat necessary to expand the chicken, the embryo, although formed entirely, will remain without any motion; and the organic molecules of which it is composed, will remain fixed without being able to give motion and life to the embryo which has been formed by their union. Thus, after the motion of the organic molecules has been destroyed, after the union of these molecules, necessary to form an animal body, there is still an external agent required to animate and give it life and motion; and this agent is heat, which, by rarefying the liquors, obliges them to circulate and put also every organ in action, which afterwards do no more than develope and grow, provided that this external heat continues to assist them in their functions.

Before the action of this external heat, not the least appearance of blood is to be seen; and it is not till twenty-four hours after, that I have perceived any change in the colour of the vessels. The blood first appears in the placenta,

which communicates with the body of the chicken: but this blood seems to lose its colour as it approaches the body of the animal; for the chicken is entirely white, and we with difficulty discover in the first, second, and third days after incubation, a few small sanguinary points which are close to the body of the animal, but which seem not to make part of it, although it is these sanguinary points which afterwards form the heart. Thus, the formation of the blood is a change occasioned in the liquors by the motion heat communicates to them, and this blood is formed even out of the body of the animal, the whole substance of which is then only a kind of mucilage, or thick jelly.

The fœtus, as well as the placenta, derives the necessary nutriment for expansion, by a kind of absorption, and they assimilate the organic parts of the liquor in which they float: for the placenta cannot be said to nourish the animal, no more than the animal nourishes the placenta; since, if the one nourished the other, the first would soon appear to diminish, while the other increased, whereas both increase together. I have indeed observed in eggs, that the placenta at first increases much more in proportion than the fœtus, and therefore it may

nourish

nourish the animal, or rather convey the nutriment to it, by intus-susception.

What we have just said concerning the chicken, is easily applied to the human fœtus, which is formed by the union of the organic molecules of the two sexes. The membranes, and placenta, are formed from the superabundance of the particles which have entered into the composition of the embryo: which is then inclosed in a double membrane, where there is also a quantity of liquor, which is, perhaps, at first, but a portion of the semen of the father and the mother; and as the fœtus does not quit the matrix, it enjoys, from the instant even of its formation, an external heat necessary for its expansion; this heat communicates a motion to liquors, and sets the organs in play, and blood is formed in the placenta, and in the body of the embryo, by the motion occasioned by this heat. It may be even said, that the formation of the blood of the infant is as independent of the mother, as that which passes into the egg, is of the hen which hatches it, or of the oven which heats it.

It is certain, that the fœtus, placenta, and membranes, grow by intus-susception: for, in the earliest days of conception, the pouch, which

contains the whole product of generation, is not adherent to the matrix. De Graaf, in his experiments on doe rabbits, made these globules, wherein the whole business of generation lies, move about in the matrix. Thus, in the first stages, they increase and grow by drawing nutriment from the liquors which bathe the matrix, to which they are afterwards attached by a mucilage, in which small vessels are formed with time, as we shall hereafter explain.

But, not to quit the subject, let us return to the immediate formation of the fœtus, on which there are many remarks to be made, both as to its situation, and the different circumstances which may prevent or stop its formation.

In the human species, the seed of the male enters into the matrix, the cavity of which is considerable; and when it meets with a sufficient quantity of female semen, a mixture of the organic particles succeed, and the formation of the fœtus ensues: the whole, perhaps, is done instantaneously, especially if the liquors are both in an active and flourishing state. The place where the fœtus is formed, is the cavity of the matrix, because the seed of the male can enter there more easily than into the trunks; and as this viscera has but one small orifice,

which

which is always shut, excepting when the ardour of love causes it to open, the materials of generation remain there with safety, and scarcely ever reissue but by rare and unfrequent circumstances: but as the liquor of the male sprinkles the vagina, before it penetrates the matrix, by the activity of the organic molecules which compose it, it may go farther into the trunks, and, perhaps, into the ovarium. As the liquor of the female has already its perfection in the glandular bodies of the testicles, from which it flows and moistens the trunks and other parts before it descends into the matrix, and as it may issue out of the vacuities left around the neck of the matrix, it is not impossible, that the mixture of the two liquors may be made in all these different places. It is, therefore, probable that fœtuses are often formed in the vagina, but which fall out as soon as they are formed, because there is nothing to retain them. It may also sometimes happen, that fœtuses are formed in the trunks; but this case is very rare, and cannot happen but when the seminal liquor of the male enters the matrix in great plenty.

The collection of anatomical observations makes mention of fœtuses not only being found

in the trunks, but also in the testicles. In the History of the Old Academy of Sciences, (vol. 11. page 91.) we meet with an observation on this subject. M. Theroude, a surgeon at Paris, shewed the academy an unformed mass, which he found in the right testicle of a girl of eighteen years of age. In it were two open slits, furnished with hair like two eyelids, above which was a kind of forehead, with a black line instead of eyebrows; immediately over that were many hairs matted together in two separate lines, one of which was seven, and the other three inches long; under the great angle of the eye, two of the grinding teeth appeared to shoot, hard, thick, and white; they had their prongs, and a third tooth thicker than the rest above them. There appeared likewise other teeth at different distances from each other: two between these, of the canine nature, issued from an opening where the ear is placed. In the same volume, page 144, it is related, that M. Mery found, in the testicle of a woman who had conceived, a bone of the upper jaw, with many teeth therein, so perfect that some appeared to be of more than ten years growth. We find, in the *Journal de Medicine*, for January 1683, published by the Abbé de la Roque, the his-

tory of a lady who died with the ninth child, which was formed in or near one of the testicles, which is not very clearly explained. The fœtus was about an inch in size, completely formed, and the sex easily to be distinguished. We also find, in the Philosophical Transactions, some observations on the testicles of women, wherein teeth, hair, and bones, have been found. If all these circumstances are true, we must suppose, that the seminal liquor of the male sometimes ascends, although very seldom, to the testicles of the female. Yet, notwithstanding all this, I have some difficulty to believe it; first, because the circumstances, which appear to prove it, are extremely rare: secondly, because a perfect fœtus has never been seen in the testicles but by M. Littre, who seems to relate it in a very suspicious manner: thirdly, because it is not impossible, that the seminal liquor of the female alone may produce organized masses, as moles, hair, bones, flesh, and, in short, because if we give credit to anatomists, fœtuses may be formed in the testicles of men, as well as in those of women: for we find, in the History of the Royal Academy, vol. II. p. 298, an observation of a surgeon, who says, he discovered in the scrotum of a man, the figure of a child

inclosed

inclosed in his membranes: and that the head, feet, eyes, bones, and cartilages, were distinguishable. If all these observations were equally true, we must necessarily adopt one of these two hypotheses, either that the seminal liquor, of each sex, cannot produce any thing without being mixed with that of the other sex, or that either of them can produce irregular masses of itself. By keeping to the first, we should be obliged to admit, to explain in all the circumstances we have related, that the liquor of the male sometimes ascends to the testicle, and, by mixing with the seminal liquor of the female, forms organized bodies; and so may also the female fluid, by being plentiful in the vagina, penetrate, during the time of copulation, into the scrotum of the male, nearly as the venereal virus often reaches that part; and that in this case, an organized body may be found in the scrotum, by the mixture of the male and female fluids; or, if we admit the other hypothesis, which appears to be the most probable, and suppose, that the seminal liquor of each individual may produce organized masses, then we may be able to say, that all these bony, fleshy, and hairy productions, sometimes found in the testicles of females, and in the scrotum

scrotum of males, may derive their origin from the liquor of the individual in which they are found. But enough of observations upon facts, which appear to be as uncertain as inexplicable, for I am much inclined to believe, that, in certain circumstances, the seminal liquor of each individual may produce something alone and of itself, and that young girls might form moles without any communication with the male, as hens form eggs without having received the cock. I might support this opinion with observations which appear to me as credible as those I have quoted. M. de la Saone, physician and anatomist of the Academy of Sciences, published a memoir on this subject, in which he asserts, that religious nuns, though strictly cloistered, had formed moles. Why should that be impossible, since hens form eggs without communication with the cock? and in the cicatrice of these eggs we perceive a mole, with appendages, instead of a chicken? The analogy appears to me to have sufficient power for us, at least to doubt, or suspend our determination. Be this as it will, it is certain that the mixture of the two liquors are required to form a fœtus, and that this mixture cannot come to any effect but when it is in the matrix,

matrix, where the anatomists have sometimes found fœtuses; and it is natural to imagine, that those which have been found out of the matrix, and in the cavity of the abdomen, have escaped by the extremity of the trunks, or by some accidental opening, and that they never fall from the testicles into the abdomen, because it is almost an impossibility that the seminal liquor of the male can ascend so high. Leeuwenhoek has computed the motion of these pretended spermatic animals to be four or five inches in forty minutes, which would be more than sufficient for the animalcules to traverse from the vagina into the matrix, from the matrix into the trunks, and from the trunks into the testicles, in an hour or two, provided all the liquor had that motion. But how is this to be conceived, that the organic molecules, whose motion ceases as soon as the liquid fails, can arrive as far as the testicles, unless brought there by the liquor in which they swim? This progressive motion cannot be given by the organic molecules to the liquor which it contains, therefore, whatever activity these molecules may be supposed to have, we cannot see how they can arrive at the testicles, and form a fœtus there, unless the liquor

liquor itself was pumped up and attracted thither, a supposition not only gratuitous but even against all human probability.

The doubts which this supposition gives rise to, confirm the opinion that the male fluid penetrates the matrix, and enters therein by the orifice, or across the membraneous coat of the viscera. The female fluid may also enter into the matrix, either by the opening at the upper extremity of the trunks, or across the skin even of the trunks and matrix. M. de Weirbrech, an able anatomist of Petersburg, confirms this opinion:——"Res omni attentione dignissima (says he) oblata mihi est in utero feminæ alicujus a me dissectæ; erat uterus ea magnitudine qua esse solet in virginibus, tubæque ambæ apertæ quidem ad ingressum uteri, ita ut ex hoc in illas cum specillo facile possem transire ac flatum injicere, sed in turbarum extremo nulla dabatur apertura, nullus aditus; fimbriarum enim ne vestigium quidem aderat, sed loco illarum bulbus aliquis pyriformis materia subalbida fluida turgens, in cujus medio fibra plana nervea, cicatriculæ æmula, apparebat, quæ sub ligamentuli specie usque ad ovarii involucra protendebatur.

 "Dices,

" Dices, eadem a Regnero de Graaf jam olim notata. Equidem non negaverim illustrem hunc prosectorem in libro suo de organis mulieribus non modo similem tubam delineasse, Tabula XIX, fig. 3, sed & monuisse, ' tubas quamvis secundum ordinariam naturæ dispositionem in extremitate sua notabilem semper coarctationem habeant, præter naturam tamen aliquando claudi ;' verum enimvero cum non meminerit auctor an id in utraque tuba ita deprehenderit ; an in virgine ; an status iste præternaturalis sterilitatem inducat : an vero conceptio nihilominus fieri possit ; an a principio vitæ talis structura suam originem ducat ; sive an tractu tempora ita degenerare tubæ possint ; facile perspicimus multa nobis relicta esse problemata quæ, utcumque soluta, multum negotii facessant in exemplo nostro. Erat enim hæc femina maritata, viginti quatuor annos nata, quæ filium pepererat quem vidi ipse, octo jam annos natum. Dic-igitur tubas ab incunabulis clausas sterilitatem inducere : quare hæc nostra femina peperit ? Dic concepisse tubis clausis ; quomodo ovulum ingredi tubam potuit ? Dic coaluisse tubas post partum : quomodo id nosti ? Quomodo adeo evanescere in utroque latere fimbriæ possunt,

tanquam

tanquam nunquam adfuissent? Si quidem ex ovario ad tubas alia daretur via, præter illarum orificium, unico gressu omnes superarentur difficultates; sed fictiones intellectum quidem adjuvant, rei veritatem non demonstrant; præstat igitur ignorationem fateri, quam speculationibus indulgere*." The difficulties which occurred to this able author are insurmountable in the egg system, but which disappear in our explanation. This observation seems only to prove what we have observed, that the seminal liquor of both male and female may penetrate the coat of the matrix, and enter across the pores of the membranes; to be assured of it, it is only necessary to pay attention to the alteration that the seminal liquor of the male causes to the viscera, and to the kind of vegetation or expansion that it causes there. Besides, the liquor which issues by the vacuities of De Graaf, being of the same nature as the liquor of the glandular bodies, it is very evident that this liquor comes from the testicles, and yet there is no vessel through which it can pass; consequently we must conclude, that it penetrates the spongy coat of all these parts,

L l 2 and

* Vide Comment. Acad. Petropol. vol. IV. page 261 and 262.

and that it not only enters the matrix, but even can issue out when these parts are in irritation.

But even should we refuse this idea of penetration, we cannot deny that the liquor of the female, which flows from the glandular bodies of the testicles, may enter by the opening at the extremity of the trunk, as that of the male does by the orifice of the viscera; and that consequently these two liquors may mix of themselves in this cavity, and form there the fœtus in the manner we have explained.

CHAPTER IX.

OF THE EXPANSION, GROWTH, AND DELIVERY OF THE FŒTUS, &c.

IN the expansion of the fœtus, two different degrees of growth make different kinds of expansion. The first, which succeeds immediately after the formation of the fœtus, is not

not proportionable in all the parts of which it is composed. The more distant it is from the formation, the more in proportion are its parts, and it is only after it has quitted the womb of its mother that the growth of the parts is made in nearly an equal manner. It must not be imagined that the figure of the fœtus, at the moment of formation, is absolutely like that of an adult. It is certain that the embryo contains every part which must compose a man, but they differ in their successive expansion.

In an organized body, as that of an animal, we may suppose some parts are more essential than others, and though some may be useless or superfluous, there are some on which the rest seem to depend for their expansion and disposition. We must consider some as fundamental parts, without which the animal cannot exist, and which are more accessory and external, and appear to derive their origin from the first, and which seem to be formed as much for the ornament, symmetry, and external perfection of the animal, as for the necessity of its existence, and the exercise of the essential functions of life. These two kinds of different parts expand successively, and are

almost

almost equally apparent when the fœtus quits the womb; but there are others which Nature seems to keep in reserve, as the teeth, which do not appear for some time, and also the glandular bodies in the testicles of females, the beards of males, &c. which do not shew themselves till the age of puberty.

In order to discover the fundamental and essential parts of an animal body, we must pay attention to the number, situation, and nature of the whole; those which are simple, those whose position is invariable, and those without which the animal cannot exist, will be the essential parts; those, on the contrary, which are double, or in a greater number, those whose size and position vary, and those which may be retrenched from the animal without destroying or even doing it an injury, may be looked upon as less necessary, and more accessory, to the animal machine. Aristotle has said that the only parts essential to animals were those with which they take their nutriment, and throw out the superfluous parts of it from the body. From the mouth to the arms are simple parts, which no other can supply. The head and spine of the back are also simple parts, whose position is invariable. The spine of the back

back serves for a foundation to the fabric of the body; and it is from the marrow which it contains that the motion and action of most of the members and organs proceed; it is also this part which appears one of the first in the embryo. Now these simple parts which appear the first are all essential to the existence and form of the animal. There are many more double than simple parts in the body of an animal, and seem to be produced on each side of the simple parts by a kind of vegetation; for these double parts are similar in form, and different in position. The left hand exactly resembles the right, because it is composed of the same number of parts; nevertheless, if it was placed in the situation of the right, we could not make use of it for the same purposes, and should have reason to regard it as a very different member. It is the same with respect to the other double parts; they are similar as to form, and different as to the position which is connected to the body of the animal; and by supposing a line to divide the body into two equal parts, the position of all the similar parts would refer to this line as a centre.

The spinal marrow, and the vertebræ which contains it, appear to be the real axis, to which

we must refer all the double parts of the animal, for they seem to derive their origin, and to be only symmetrical branches issuing from this trunk or common base, for we see the ribs shoot out on each side of the vertebræ in the young chicken as the young branches shoot out from the principal branch of a tree. In all embryos the middle of the head and vertebræ appear to be the first formed; afterwards we see on the two sides of a vesicle which forms the middle of the head two other vesicles which appear to proceed from the first. These two vesicles contain the eyes and the other double parts of the head; so likewise we perceive little tubercles shoot out in equal numbers from each side of the vertebræ, which extend by degrees and form the ribs, and other donble parts of the trunk. On the side of this trunk already formed, as the conclusion, the legs and arms appear. This first expansion is very different from that which is made afterwards; it is the production of parts which appear for the first time; that which succeeds is only a growth of all the parts already created.

This symmetrical order of all the double parts found in every animal, the regularity of their position, the equality of their extension and

and growth, and the perfect resemblance between them, seem to indicate that they derive their origin from the simple parts; that there must reside in these simple parts a power which acts equally on each side, or, which answers the same meaning, they are the fixed points against which the power that produces the expansion of the double parts is exercised. That the power which acts on the right is equalled by that of the left side, and consequently they are counterbalanced by this re-action.

From hence we may infer, that if there is any defect or excess in the matter which is to serve for the formation of the double parts, as the powers which impel them on each side are equal, the defect or excess must be formed the same both on the right and left; for example, if, from a defect of matter, a man has but two fingers instead of five on the right hand, he will have but two on the left hand; or if, by an excess of matter, he has six fingers on one hand, he will have six on the other; or if the matter be vitiated, and causes an alteration in the right part, it will be the same on the left. This fact is very often seen. Most monsters are made with symmetry; the disarrangement of the parts of monsters appears to

to be made with order: Nature, therefore, even in her errors, mistakes as little as possible.

This harmony of position in the double parts of animals is found also in vegetables; branches shoot out from buds on every side; the veins in the leaves are equally disposed as to the principal vein; and although symmetrical order appears to be less exact in vegetables than in animals, it is only because it is more varied, and its limits are more extended, and less precise; but we may nevertheless easily discover this order, and distinguish the simple and essential parts from those which are double, and the latter we must regard as having taken their origin from the former. We shall more fully discuss this point, as far as relates to vegetables, when we come to treat of them.

It is not possible to determine under what form the double parts exist before expansion, nor in what manner they are folded, nor what figure results from their position by connection with the simple parts. The body of the animal, in the instant of formation, certainly contains every part which is to compose it; but the relative position of these parts must be very different then from what it becomes afterwards. It is the same with vegetables, for if we

we observe the expansion of a young leaf, we shall perceive that it is folded on both sides the principal vein, and that its figure does not resemble at that time what it afterwards assumes.

When we amuse ourselves by folding paper to form crowns, boats, &c. the different folds of the paper seem to have no resemblance to the form which must result by the unfolding; we only see that these folds are always made in an uniform order, and exactly the same on one side as that we have made on the other; but it would be a problem beyond known geometry, to determine the figures which may result from all the unfoldings of a certain given number of folds. All what immediately relates to the position, is beyond our mathematical sciences. This art, which Leibnitz calls *Analysis Situs*, is not yet found out; though the art, which would shew us the connections that result from the position of things, would perhaps be more useful than that which has only bulk for its object, for we have often more need to know the form than the matter.

In the unfolding of Nature's productions, not only the folded parts take new positions, but they acquire, at the same time, extent and solidity. Since we cannot therefore deter-

mine the result of the simple unfolding of a folded form, in which, as in a piece of folded paper, there is but one change of position between the parts, without any augmentation or diminution of the bulk or mass of the matter, how is it possible for us to judge of the complex unfolding of the body of an animal, in which not only the relative position of the parts, but also their mass of matter, undergoes considerable changes? We cannot, therefore, reason upon this subject, but by drawing some inductions from the examination of the things at the different periods of their unfolding, and by assisting ourselves with the observations that we have had the opportunity to make.

It is true we see the chick in the egg before incubation; it floats in a transparent liquor, contained in a small purse, formed by a very fine membrane in the centre of the cicatrice; but this chick is then only a particle of inanimate matter, in which we cannot discern any organization, nor any determined figure. We judge by the external form that one of the extremities is the head, and the rest to be the spine of the back. It appears that this is the first product of fecundation resulting from the mixture of the seed of the male and female;

nevertheless,

nevertheless, before asserting this as a fact, there are many things should be considered. When the hen has cohabited with the cock for a few days, and afterwards separated from him, the eggs she produces for a month after separation are as fertile as those she produced during the time of cohabitation with the male, and unfold at the same time; they only require twenty-one days sitting, and the embryo of the one will be as forward and as completely formed as that of the other. From hence we might think, that this form, under which the chick at first appears to us in the egg, does not immediately proceed from a mixture of the two liquors, but that it existed in other forms during the time the egg remained in the body of the mother; for the embryo in the form we see it before incubation, requires only heat to unfold and bring it forth. Now, if it had this form twenty days, or a month before, when the egg was first fecundated, why was it not hatched by the internal heat of the hen? and why is not the chicken perfectly formed in those eggs which are fecundated twenty-one days before the hen lays them?

This difficulty is not so great as it appears; for we must conceive, that in the time of the

cock's cohabitation with the hen, each egg receives in its cicatrice, wherein the female liquor is contained, a small portion of the semen of the male. The egg attached to the ovary is in oviparous females, what the glandular substance is in the testicles of viviparous females. The cicatrice of the egg corresponds with the glandular bodies in which the seminal liquor of the female resides; that of the male penetrates and mixes there with it; from this mixture, the formation of the embryo instantly results. The first egg which the hen lays after coition is fecundated, and capable of producing a chicken; those which she lays afterwards were fecundated at the same instant; but as there is still wanting essential parts to this egg, the production of which is independent of the seed of the male, as the white, membranes, and shell, the young embryo contained in the cicatrice cannot unfold in this imperfect egg, although assisted by the internal heat of the mother. It remains, therefore, in the cicatrice in the state in which it was formed, until the egg has acquired all the parts necessary to the growth and nourishment of the chicken: and it is not till the egg has attained its perfection that the embryo begins to unfold: this

this unfolding is performed by the external heat of incubation; but it is certain, if the egg could be confined within the body of the hen for 21 days after it was completely formed, the chicken would be produced, unless the internal heat of the hen should prove too powerful, for the degrees of heat necessary to hatch chickens are not very extended, and the least defect or excess is equally prejudicial to their unfolding. The last eggs the hen lays, containing the same as the first, proves nothing more than that the egg must acquire entire perfection before the embryo can unfold itself; and for want of the heat necessary to this unfolding, eggs may be kept a considerable time before incubation, without preventing the produce of the chickens they contain.

It appears, therefore, that the state of the embryo, when the egg is laid by the hen, is the first state which succeeds fecundation; that the form under which we see it is the first form resulting from the intimate mixture, and form the penetration of the two seminal liquors; and consequently by following, as Malpighius has done, this unfolding from hour to hour, we discover all that is possible to be known, unless we could see the two liquors mix before our

eyes, and how the first arrangement of the particles are made, which produces the first form of the embryo.

If we reflect on this fecundation (which is made at the same time) of these eggs, which are laid successively, and a long time after each other, we shall find new arguments against the existence of eggs in viviparous animals; for if the females of viviparous animals, or if women contained eggs, like hens, why are there not many fecund at the same time? why are not some of them produced in nine months, and others at distant periods? and when women have two or three children, why do they all come into the world at one time? If these fœtuses were produced by the means of eggs, would not they come successively, according as the eggs come to perfection, after the time of impregnation? And would not super-fœtation be as frequent as they now are scarce, or as natural as they appear to be accidental?

We cannot follow the unfolding of the fœtus in the matrix as we pursue that of the chick in the egg; the opportunities of observing it are few, and we can only know what anatomists, surgeons, and midwives have written

written thereon. It is by collecting all their particular observations, and by comparing their remarks and their descriptions, that we have made the following abridged history of the human fœtus.

There is a great appearance that, immediately after the mixture of the two seminal liquors, the whole materials of generation exist in the matrix under the form of a globe; since we know, by anatomists, that three or four days after conception there is a small oval ball in the matrix, this ball is formed by an extremely fine membrane, which incloses a limpid liquor like the white of an egg. We can then perceive some small united fibres in this liquor, which are the first outlines of the fœtus. A net-work of fine fibres collects on the surface of the ball, which extends from one of the extremities to the middle. These are the first vestiges of the placenta.

Seven days after conception we may distinguish, by the naked eye, the first lineaments of the fœtus, as yet unformed; being only a mass of transparent jelly, which has acquired some small degree of solidity; the head and trunk are easily discernible, because this mass is of an oblong form, and the trunk is more delicate

and somewhat longer. Some small fibres, in form of a plume of feathers, spring from the body of the fœtus, and which turn towards the membrane in which it is included; these fibres are to form the umbilical cord.

Fifteen days after conception, the head, and the most apparent features of the face, are distinguishable; the nose resembles a small prominent and perpendicular thread affixed to a line, which indicates the division of the lips. Two small black points are in the places of the eyes, and two little holes in those of the ears; the body of the fœtus has also received some growth. On each side of the upper and inferior parts of the trunk, little protuberances appear, which are the first outlines of the arms and legs.

Eight days after, that is in three weeks, the body of the fœtus has only increased about a line; but the arms and legs, the hands and feet, are apparent; the growth of the arms is more quick than that of the legs, and the fingers separate sooner than the toes. At this time internal organization begins to be discernible; the bones appear like small threads as fine as hairs; the ribs are disposed regularly from the two sides of the back bone; and as well as the

arms,

arms, legs, fingers, and toes, are represented by very small threads.

At a month the fœtus is more than an inch long; it naturally takes a curved posture, in the middle of the liquor which surrounds it, and the membranes which contain the whole are increased in extent and thickness; the mass is oval, and it is then about an inch and an half in its greatest, and an inch and a quarter the smallest diameter. The human figure is no longer equivocal, every part of the face is already discernible; the body is fashioned, the thighs and belly are seen, the limbs formed, the toes and fingers divided, the skin thin and transparent, the viscera marked by fibres, the vessels as fine as threads, and the membranes extremely delicate, the bones are as yet soft, and have only taken solidity in some few parts; the vessels which compose the umbilical cord, are as yet in a straight line by the side of each other; now the placenta only occupies a third of the whole mass; whereas in the beginning it occupied the half. It appears, therefore, that its growth, in superficial extent, has not been so great as that of the fœtus, and the rest of the mass; but it has increased much more in solidity; its thickness has become greater

in proportion than the membranes of the fœtus, both of which are now easily distinguished.

According to Hippocrates, the male fœtus is developed sooner than the female. He says all parts of the body in the first are apparent in thirty, whereas the latter are not so till the expiration of forty-two days.

In six weeks the fœtus is nearly two inches long; the human figure begins to be more perfect; the head is only larger in proportion than the other parts of the body; the motion of the heart is perceived about this time. It has been seen to beat in a fœtus of sixty days, a long while after it had been taken out of the womb of its mother.

In two months the fœtus is more than two inches long; the ossification is discernible as far as the middle of the arm, thigh, and leg, and in the point of the lower jaw, which is then very forward before the upper. These, however, are only ossified points; but by the effect of a more ready expansion, the clavicles are wholly ossified. The umbilical cord is formed, and the vessels which compose it, begin to twist nearly like threads which compose a rope; but this cord is still very short in comparison of what it becomes hereafter.

In

In three months the fœtus is nearly three inches long, and weighs about three ounces. Hippocrates says, that it is at this time the motion of the male fœtus begins to be felt by its mother; but that those of the female are not felt till after the fourth; there are women who affirm they have felt the motions of the child at the beginning of the second month. It is very difficult to be certain on this subject, the sensations excited by the first motions of the fœtus depending, perhaps more on the sensibility of the mother than the strength of the child.

Four months after conception the length of the fœtus is six or seven inches: every part of its body is so greatly augmented as to be perfectly distinguished from each other; even the nails appear on the fingers and toes. The testicles of the males are shut up in the belly above the kidneys; the stomach is filled with somewhat of a thick humour, like that which incloses the amnios. We find a milky fluid in the little vessels, and in the large ones a black liquid matter. There is a little bile in the gall, and some urine in the bladder. As the fœtus floats freely in the liquid which surrounds it, there is always a space between the body and membranes in which it is contained.

These

These coverings grow at first more than the fœtus; but after a certain time it is quite the contrary. Before the end of the third month the head is bent forward, the chin rests on the breast, the knees are lifted up, the legs bent backwards upon the thighs (sometimes the knees are so high as almost to touch the jaws), the arms are generally folded across the breast, and one of the hands, and often both touch the face. The fœtus afterwards takes different situations, as it acquires strength. Experienced midwives have pretended to be certain that it changes much oftener than is commonly thought, and which they prove by several observations; first, the umbilical cord is often found twisted round the body and limbs of the child, in a manner which necessarily supposes, that the fœtus has moved in many directions, and taken different positions; secondly, a mother feels the motions of the fœtus sometimes on one side of the womb and sometimes on another; and it often strikes against many different places, which must be occasioned by different positions, and supposes that it takes different situations; thirdly, as it floats in a liquid which surrounds it on all sides, it can very easily turn and extend itself by its own strength; and it must also take different

ferent situations according to the various attitudes of the mother; for example, when she lies down, the fœtus must be in another situation to what it was when she stood upright.

Most anatomists have said, that the fœtus is constrained to bend its body, because it is too confined in its covering; but this opinion does not appear well founded, for in the first five or six months there is more space than is required for the fœtus to extend, and yet during that time it is bent and folded. We also see the chicken is in a curved posture in the liquor of the amnios, although this membrane and its liquor are sufficient to contain a body five or six times as large as the fœtus. Thus we may conclude that this curved form of the fœtus is natural, and not the effect of force. I am somewhat of Harvey's opinion, who says, it takes this attitude because it is the most favourable to rest and sleep; and as the fœtus sleeps almost continually, it naturally takes the most advantageous situation. "Certe (says this famous anatomist) animalia omnia, dum quiescunt & dormiunt, membra sua ut plurimum adducunt & complicant, figuramque ovalem ac conglobatam quærunt: ita pariter embryones qui ætatem suam maxime somno

 transigunt,

transigunt, membra sua positione ea qua plasmantur (tanquam naturalissima ac maxime indolenti quietique aptissima) componunt*."

The matrix, as we have already said, takes a very ready growth after conception, and it continues also to increase in proportion with the fœtus; but the fœtus at length outgrows the matrix, and then, especially when it approaches maturity, it may be too much confined, and agitate the matrix by reiterated motions and violent efforts. The mother sensibly feels the impression of these painful sensations, and which are called periodic pains after the labour commences. The more power the fœtus exerts to dilate the matrix the greater it finds the resistance, from the natural compression of the parts. From thence all the effect falls on the orifice, which has been increasing by degrees during the latter months of pregnancy. The head of the fœtus, forcibly inclining against the sides of the orifice, dilates it, by a continual pressure, till the moment of delivery, when it opens sufficiently for the child to escape from the womb.

What makes it probable that the labour-pains proceed only from the dilatation of the orifice

* Harvey on Generation, page 257.

orifice of the matrix is, that this dilatation is the only means to discover whether the pains felt are in fact the pains of labour, for women often feel very sensible pains, which are not those that immediately precede delivery. To distinguish the false from true pains, it has been recommended for the midwife to touch the orifice of the matrix, as if the pains be true the dilatation will always increase, and if they are false pains, that is to say, pains which proceed from some other cause than that of the approaching delivery, the orifice will contract rather than dilate, or at least will not continue to dilate. From hence we have sufficient foundation to imagine, that these pains proceed from a forced dilatation of the orifice. The only thing which embarrasses on this occasion is that alternative of rest and sufferings the mother endures. This circumstance of the effect does not perfectly agree with the cause which we have just indicated; for the dilatation of an orifice, which is made by degrees, should produce a constant and continued pain, without any intervals of ease. But possibly the whole may be attributed to the separation of the placenta, which we know is fastened to the matrix by a number of papillæ, which pene-

 trate

trate into the vacuities or cavities of this viscera; therefore may it not be supposed that they do not separate from their cavities all at the same time; that each separation causes those acute pains, and the intervals between are those of ease and rest? The effect in this case perfectly answers the cause, and we can support this conjecture by another observation.—Immediately before delivery there issues a whitish and viscous liquor, like that which flows from the nipples of the placenta when drawn out of their places, which makes it probable that this liquor, which then issues from the matrix, is produced by the separation of some of the papillæ of the placenta.

It often happens that the fœtus quits the matrix without bursting the membranes, and consequently without the contained liquor flowing out. This kind of delivery appears to be most natural, and resembles that of most animals; nevertheless, the human fœtus commonly pierces its membranes by the resistance it meets with at the orifice of the matrix. It also sometimes brings away part of the amnios, and even the chorion, upon its head like a cap. When these membranes are pierced or torn, the liquors, called the *waters*, which they con-

tain flow out, and the sides of the orifice of the matrix, and the vagina, being thus moistened, give way more easily to the passage of the child. After the flowing of this liquor there remains sufficient room in the matrix for the midwife to return the child, if the position is unfavourable. When the fœtus is come out the delivery is not entirely completed, the placenta and membranes remain in the matrix, and the new-born infant adheres to them by the umbilical cord; the hand of the midwife, or the weight of the body of the infant alone, draws them out by means of this cord. Those organs which were necessary to the life of the fœtus become useless, and even noxious to the new-born infant. They are instantly separated from the body of the child, by tying the umbilical cord about an inch distance from the navel, and by cutting it about an inch from the ligature. The remainder of this cord dries away, and separates of itself from the navel, about the sixth or seventh day.

On examining the fœtus previous to its birth we may form some idea of its natural functions. It has organs, which are necessary to it while in the womb of its mother, but which become useless. For the better under-

standing the mechanism of these functions, we must explain a little more particularly the nature of those necessary parts, the umbilical cord, the membranes, the liquor which they contain and the placenta. The umbilical cord, which is attached to the body of the fœtus at the navel, is composed of two arteries and one vein; these prolong the circulation of the blood, but the vein is larger than the arteries. At the extremity of the cord each of these vessels divide into an infinity of ramifications, which extend between two membranes. They separate at equal distances from the common trunk; so that these ramifications are round and flat, and are called, when thus collected, the *placenta*. The external surface, which is applied against the matrix, is convex; the internal concave. The blood of the fœtus circulates in the cord, and in the placenta. The arteries of the cord spring from two large arteries of the fœtus, and carry the blood through the arterial ramifications of the placenta; from thence it passes into the venous branches which carry it into the umbilical vessels; these communicate with a vein of the fœtus, in which vessels it is received.

The

The concave surface of the placenta is clothed by the chorion; the convex is also covered by a kind of soft membrane, easily torn, which seems to be a continuation of the chorion, and the fœtus is included under the double coat of the chorion and the amnios. The form is globular, because the intervals between the membranes and the fœtus are filled with a transparent liquor. This liquor is contained by the amnios, which is the internal membrane, it is thin and transparent; it folds round the umbilical cord at its insertion into the placenta, and covers it the whole length to the navel of the fœtus. The chorion is the external membrane; it is thick and spongy, sprinkled with sanguinary vessels, and composed of many coats, the exterior of which covers the convex surface of the placenta. It follows the inequalities, and covers the papillæ, which spring from the placenta, and are received in the cavities found at the bottom of the matrix, called *lacunæ*. The fœtus adheres to the matrix by these insertions.

Some anatomists have thought that the human form had, like those of certain quadrupeds, a membrane called *allantois*, destined

to

to receive the urine; and they have pretended to have found it between the chorion and the amnios, or in the middle of the placenta at the root of the umbilical cord, under the form of a very large bladder, in which the urine entered by a long pipe that composed part of the chord, and which opened on one side into the bladder, and on the other in this allantois membrane, being similar to the urachus in other animals. They owned, however, that it was not near so large in the human fœtus as in quadrupeds, but that it was divided into many tubes, so minute, that they could scarcely be perceived, and that the urine passed into their cavities.

The experience and observations of most anatomists are contrary to this supposed discovery. They admit there is a kind of ligament which adheres by one end to the external surface of the bottom of the bladder, and extends to the navel; but it becomes so delicate, on entering into the cord, as to be nearly reduced to nothing: in common this ligament is not hollow, and we can see no orifice at the bottom of the bladder.

The fœtus has no communication with the open air, and the experiments made upon the

lungs

lungs prove they have never respired; for they sink to the bottom when put in water: whereas those of infants who have breathed always float on the top; the fœtus then does not respire in the womb, consequently it cannot form any sound by its voice; and therefore what has been related of the groaning and crying of children before their birth may be considerered as fables. After the flowing of the waters it may happen, that the air has found an entrance into the cavity of the matrix, and then the infant may begin to respire before it is brought forth. In this case it may be able to cry, as the chicken cries before the shell of the egg is broken, which it can do from there being air in the cavity which is between the external membrane and the shell. This air is found in all eggs, and is produced by the internal fermentation of matters contained in them*.

The lungs of the fœtus being without any motion, have no more blood enter into them than is requisite to nourish and make them grow; and there is another road opened for the course of its circulation. The blood in the right auricle of the heart, instead of passing into

* See La Statique des Vegetaux, Chap. vi.

into the pulmonary artery, and returning, after having ran through the lungs into the left auricle by the pulmonary vein, passes immediately into the left by an opening, called the *foramen ovale*, which is in the partition of the heart between the two auricles. It enters afterwards into the aorta, which distributes it by its ramifications; at going out of which the venous branches receive it, and bring it back to the heart by uniting all in the *vena cava*, which terminates at the right auricle of the heart. The blood which this auricle contains, instead of passing entirely by the foramen ovale, may escape in part into the pulmonary and the aorta by an arterial canal, which goes immediately from the one to the other. It is by these roads that the blood of the fœtus circulates without entering into the lungs, as it enters into those of children, adults, and every animal which breathes.

It has been thought that the blood of the mother passes into the body of the fœtus, by means of the placenta and umbilical cord. It was supposed that the sanguinary vessels of the matrix opened into the vacuities, and those of the placenta into the nipples, and that they joined one to the other; but experience is quite

quite contrary to this opinion; for if the arteries of the umbilical cord is injected the liquor returns by the veins, and not any part of it escapes externally. Besides, the nipples may be drawn from the vacuities where they are lodged, without any blood issuing either from the matrix or placenta: a milky liquor only issues from both, and which, we have already observed, serves the fœtus for nutriment. This liquor possibly enters into the veins of the placenta, as the chyle enters into the subclavian vein; and perhaps the placenta in a great measure performs the office of the lungs in bringing the blood to maturity. It is certain that the blood appears much sooner in the placenta than in the fœtus, and I have often observed in eggs that have been under the hen for a day or two, that the blood appeared at first in the membranes, and that their sanguinary vessels are very large and numerous, while the whole body of the chicken, excepting the point where these blood-vessels terminate, is only a white and almost transparent matter, in which there is not the smallest sign of a sanguinary vessel.

It has been imagined, that the liquor of the amnios is a nutriment the fœtus receives

ceives by its mouth. Some naturalists pretend to have observed this liquor in the stomach, and to have seen some fœtuses to which the umbilical cord was entirely wanting, and others who had but a very small portion, which did not at all adhere to the placenta; but in this case might not the liquor have entered into the body of the fœtus by the small portion of the umbilical cord, or by the umbilical vessel itself? besides, to these observations we may oppose others. Some fœtuses have been found whose lips were not separated, and others without any opening in the œsophagus. To concilitate these circumstances, some anatomists have thought that the aliments passed into the fœtus partly by the umbilical cord, and partly by the mouth: none of these opinions appear to have any foundation. It is not the question to examine the growth of the fœtus alone, and to seek from whence and by what it draws its nutriment, but how the growth of the whole is made; for the placenta, liquor, and membranes increase in size as well as in the fœtus; and consequently the instruments and canals employed to receive or carry this nutriment to the fœtus, have a kind of life themselves. The expansion of the placenta and membranes

is as difficult to conceive as that of the fœtus; and we might say, with equal propriety, that the fœtus nourishes the placenta, as that the placenta nourishes the fœtus. The whole mass is floating in the matrix, and without any adherence at the commencement of this growth: therefore the nourishment can be only made by an absorption of the milky matter contained in the matrix. The placenta appears first to draw this nutriment, to convert this milk into blood, and to carry it to the fœtus by veins. The liquor of the amnios appears to be only this milky liquor depurated, the quantity of which increases by a like absorption, proportionate to the increase of the membranes, and the fœtus probably absorbs the liquor, which appears to be the necessary nutriment for its expansion. For we must observe, that for the first two or three months the fœtus contains very little blood; it is as white as ivory, and appears to be composed of lymph which has taken some solidity; and as the skin is transparent, and all the parts very soft, we may easily conceive that the liquor in which the fœtus swims may penetrate them, and thus furnish the necessary matter for its nutrition and expansion. It may be supposed

that the fœtus in the latter stages takes its nutriment by the mouth, since in the stomach we find a liquor similar to that in the amnios, urine in the bladder, and excrements in the intestines; and as we find neither urine nor *meconium* in the amnios, there is reason to conclude that the fœtus does not void its excrements, especially as some are born without having the anus pierced, although they had a great quantity of *meconium* in the intestines.

Although the fœtus does not immediately adhere to the matrix, but is only attached to it by small external nipples, though it has no communication with the blood of its mother, but is as independant of her who bears it, in many respects, as the egg is of the hen that hatches it, yet it has been pretended, that all which affects the mother affects the fœtus; that the impressions of the one act on the brain of the other; and to this imaginary influence resemblances, monsters, and especially marks on the skin of some children, have been attributed. I have examined many of these marks, and they all appear to me to have been caused by a derangement in the texture of the skin. Every mark must have a figure which will resemble something or other; but I am certain the re-

semblances

semblances so formed depend rather on the imagination of those who see them than on that of the mother. On this subject the marvellous has been carried as far as it could go. It has not been only said that the fœtus carried real representations of the longings of its mother, but that, by a singular sympathy, the marks, which represent strawberries, cherries, &c. change their colour, and become deeper in the season of those fruits. With a little more consideration, and less prejudice, this colour may be seen to change much oftener, and that it must happen every time the motion of the blood is accelerated, whether by the heat of summer or from any other cause. These marks are either yellow, red, or black, because the blood gives these tints to the skin when it enters in too great quantities into the vessels. If these marks have the longings of the mother for their cause, why have they not the forms and colours as varied as the objects of her desires? What a curious assemblage of figures would be seen if all the whimsical desires of the mother were written on the skin of the child?

As our sensations have no resemblance to the objects which cause them, it is impossible that

desire,

desire, fear, horror, or any passion, or internal emotion, can produce real representations of those objects; and the child being in this respect as independant of the mother as the egg is of the hen, I should as soon believe that a hen, which saw the neck of a cock twisted, would hatch chickens with wry necks, as that, by the power of imagination, a woman, who happened to see a man broke upon the wheel, would bring forth a child with its limbs broken in the same manner.

But even supposing this circumstance attested, I should still support the opinion, that the imagination of the mother had not been the cause, for what is the effect of horror? an internal motion, a convulsion in the body of the mother, which might shake, compress, and agitate the womb. What can result from this commotion? nothing similar to the cause, for if this commotion was very violent the fœtus might be killed, wounded, or deformed in some of its parts; but how is it to be conceived that this commotion can produce any thing resembling the fancy of the mother in the fœtus, unless we believe, with Harvey, that the matrix has the faculty of conceiving ideas, and realizing them on the fœtus?

But,

But, it may be urged, if it was not affected by the imagination of the mother, why did the child come into the world with broken limbs? However rash it may appear to explain a matter which is extraordinary and uncertain, and of which we have no right to exact a solution, yet this question appears to me answerable in a satisfactory manner. Circumstances of the most rare and extraordinary kind happen as necessarily as those which are frequent and common. In the infinite combinations which matter can take, the most extraordinary arrangements must sometimes happen; hence we might venture to wager, that in a million, or a thousand millions of children, there will be one born with two heads, four legs, or with broken limbs; it may, therefore, naturally happen, without the concurrence of the mother's imagination, that a child should be born with broken limbs. This may have happened more than once, and the mother, while pregnant, might have been present at the breaking on the wheel, and therefore the defect of the child's formation has been attributed to what she had seen, and to her impressed imagination. But, independant of this general answer, we may give a more direct explanation. The fœtus,

as

as we have said, has nothing in common with the mother; its functions, organs, blood, &c. are all particular, and belong to itself; the only thing which it derives from its mother is the liquor, or nutritive lymph, which filtrates from the matrix. If this lymph is bad, or envenomed with the venereal virus, the child will be alike disordered; and it may be imagined, that all the diseases which proceed from vitiated humours may be communicated from the mother to the child. We know that the small-pox is communicative, and we have but too many examples of children who are, directly after their birth, the victims of the debauches of their parents. The venereal virus attacks the most solid parts of the bones, and it appears to act with more force towards the middle of the bone, where ossification commences; I conceive, therefore, that the child here spoken of has been attacked by the venereal disorder while in its mother's womb, and from that cause it came into the world with its bones broken through the middle.

Rickets may also produce the same effect. There is a skeleton of a rickety child in the French king's cabinet, whose arms and legs have callosities in the middle of their bones.

By

By the inspection of this skeleton, it appeared evident that the bones had been broken during the time it was in the womb, and that afterwards the bones re-united, and formed these callosities.

But enough of a subject which credulity alone has rendered marvellous. Prejudice, especially that sort which is founded on the marvellous, will always triumph over reason, and we should have but little philosophy if we were astonished at it. We must not therefore ever expect to be able to persuade women, that the marks on their children have no connection with their unsatisfied longings. Yet might it not be asked them, before the birth of the child, of what particular longings they had been disappointed, and consequently what will be the marks their children will bear? I have often asked this question, and have only made persons angry without having ever convinced them.

The time that a woman goes with child is generally about nine months; but it is however sometimes longer and sometimes shorter. Many children are born at seven or eight months, and some not till after the ninth; but in general the deliveries which precede the term of nine

months are more frequent than the others. The common time of a natural delivery extends to twenty days, that is, from eight months fourteen days to nine months and four hours.

Many children are born before the 260th day, and although these deliveries precede the general term, they are not abortions, because these children mostly live. It is commonly thought that children born at eight months cannot live, or at least that many more of them die than those born at seven months. This opinion appears to be a paradox; and by consulting experience I think we shall find it an error. The child brought forth at eight months is more formed, and consequently more vigorous, and likely to live than that which is born at the seventh. evertheless this opinion is pretty generally received, and founded on the authority of Aristotle.

The beginning of the seventh month is the earliest term for delivery; if the fœtus is brought forth sooner it dies, and is termed an abortion. There are, however, great limits for the time of human delivery, since they extend from the seventh to the tenth, and perhaps to the eleventh month.

Women

Women who have had many children assert, that girls remain longer in the womb than boys. If this is really the case, we must not be surprized at female children being born at ten months. When children come before nine months they are not so well proportioned as those who are not brought into the world till ten months, the bodies of the latter are sensibly larger and better formed; their hair is longer, the growth of the teeth, although still hid under the gums, is more advanced; the voice is clearer, and the tone more deep.

There is much uncertainty on the occasional causes of delivery, and we do not perfectly know what obliges the infant to quit the womb. Some imagine, that the fœtus having acquired a certain size, the matrix is too confined for its longer stay, and that the constraint felt by the fœtus, obliges it to use every effort to quit its prison; others say, and it is nearly to the same purport, that the weight of the fœtus becomes so great, that the matrix is forced to open to free itself from the burthen. These reasons do not appear satisfactory; for the matrix must always have capacity and strength to contain and sustain the weight of a fœtus of nine months, since it often contains two, and it is certain that the

weight and size of the twins of eight months are more considerable than the weight and size of a single child of nine. Besides, it ofte happens that a child born at nine months is smaller than the fœtus of eight months, although it continues in the womb.

Galen pretends, that the child remains in the matrix till it is able to receive its food by the mouth, and that it only forces its escape from the need of nutriment. Others have said, that the fœtus always receives its nourishment by the mouth from the liquor of the amnios; but which becomes at length so contaminated, by the transpiration and urine of the fœtus, that it becomes disgustful, and obliges the fœtus to use every exertion to quit its confinement. These reasons do not appear better than the first; for it would from thence follow, that the weakest and smallest fœtuses would remain longer in the womb than the strongest and largest, which never happens; besides, it is not food that the fœtus seeks immediately after it is born, for it can stay some time without it; on the contrary, it seems most desirous to disembarrass itself from the nutriment it took when in the womb of its mother, and to return the meconium. Other anatomists have supposed that the

the excrement accumulated in the bowels of the fœtus, gives it great pain, and causes it to make such efforts, that the matrix is at length obliged to give way, and to open a passage for its escape. I acknowledge I am not better satisfied with this explanation than the rest; because, why cannot the fœtus void its excrements in the amnios, if it was pressed so to do? Now this never happens; it appears, on the contrary, that this necessity of voiding the meconium is not felt till after the birth, when the motion of the diaphragm, occasioned by that of the lungs, compresses the intestines and causes this evacuation; for the meconium has never been found in the amnios of a fœtus of ten months who had not respired, whereas a fœtus of six or seven months voids this meconium a short time after respiration.

Other anatomists, and among them Fabricius de Aquapendente, have supposed the fœtus quitted the matrix through the need of procuring refreshment by means of respiration. This cause appears to me still more remote than all the rest, because the fœtus can have no idea of respiration without having respired.

After having weighed all these explanations, I suppose the fœtus's quitting the matrix depends

pends on a quite different cause. The flowing of the menstrua is periodical, and at determined intervals; and although conception suppresses its appearance, it does not destroy the cause; for notwithstanding the blood does not appear at the accustomed times, yet a kind of revolution takes place, like that which is made before conception. Thus it is, there are many women whose menstrua are not suppressed in the first two or three months. I imagine, therefore, that when a woman has conceived, the periodical revolution is made as regular as before; but as the matrix is swelled, the excretory canals cannot give issue to the blood, at least unless it arrives there with such force, and in such quantities, as to open a passage in spite of the resistance that is opposed to it. In this case blood will appear, and if it flows in a great quantity abortion will ensue, and the matrix take the form it had before. But if the blood only forces one part of these canals, the business of generation will not be destroyed, although the blood appears, because the greatest part of the matrix still remains in the state which is necessary for that purpose.

When no blood appears, as is generally the case, the first periodical revolution is remarkable

and felt by the same pains and symptoms. From the first suppression of the menses, therefore, a violent action on the matrix is made, and provided the action is augmented, it destroys the product of generation. It may from thence be concluded, that every conception which is made just before the useful return of the menses seldom succeeds, and that the action of that blood easily destroys the weak roots of a germ so tender and so delicate. The conceptions, on the contrary, which are made just after the periodical evacuations succeed the best, because the produce of the conception has more time to grow, strengthen, and resist the action of the blood, by the time the next revolution happens.

The fœtus having undergone this first trial, and having resisted it, receives more strength and growth, and is more in a condition to contend against the succeeding revolutions. Miscarriages may and do happen in all the periodical revolutions; but they are less frequent in the fourth and fifth months, than either at the beginning or near the end. We have assigned the reasons why they are more frequent at the beginning; it therefore only remains to explain why they are also more frequent towards the end.

The

The fœtus generally comes into the world during the tenth revolution. When it is born at the eighth or ninth it lives, and these deliveries are not looked upon as miscarriages, because the child, although not so perfectly formed, is still sufficiently so for the purpose of life. It has been pretended, that examples have been seen of children born at the seventh and even at the sixth revolution, that is, at five or six months, which have lived. There is, therefore, no difference between a birth and a miscarriage but what is relative to the living powers of the infant. In general the number of miscarriages in the first, second, and third months are very considerable for the reasons we have given; and the number of deliveries of the seventh and eighth months are also very great, in comparison with the miscarriages of the fourth, fifth, and sixth months, because in this middle period the product of generation has received more solidity and strength, and having resisted the action of the four first periodical revolutions, a more violent force than the preceding is required to destroy it. The same reason subsists, with additional force, for the fifth and sixth months. But the fœtus, which till then is weak, and can act only by its own feeble

feeble strength, begins to get strong, and move with vigour; and at the eighth revolution the fœtus, uniting its efforts with those of the matrix, facilitates its exclusion, and it may come into the world in the seventh month, and be capable of living, especially if it happens, as is sometimes the case, to have more than ordinary strength for that period. But if it comes into the world only through the weakness of the matrix, which could not resist the action of the blood in this eighth revolution, the delivery would be regarded as a miscarriage, and the child would not live. But these cases are very rare, for if the fœtus has resisted the seven first revolutions, only particular accidents can prevent it from resisting the eighth. The fœtus, which has acquired this same degree of strength and vigour only a little later, will come into the world at the ninth revolution; and those which require nine months to obtain this same strength, will come at the tenth revolution, which is the most common and general term; but when the fœtus has not acquired in nine months this degree of perfection, it may remain in the womb till the eleventh, and even till the twelfth revolution; that is, till the tenth or eleventh month, as we have many examples.

This opinion, that it is the menstrua which is the occasional cause of delivery at different times, may be confirmed by many other reasons. The females of every animal which have no menses, bring forth at nearly the same terms, and there is but a very slight variation in the duration of their gestation. We may, therefore, suppose that this variation, which is so great in women, comes from the action of the menstrual blood, which is constantly exerted at every periodic return.

We have observed, that the placenta adheres to the papillæ, or the matrix, only by nipples; that there is no blood either in these nipples or in the vacuities they are niched into, and that when they are separated (which is easly done) a milky liquor only issues from them. Now, how happens it that delivery is always accompanied with a considerable hæmorrhage, at first of pure blood, and afterwards mixed with a watery liquor? This blood does not proceed from the separation of the placenta, as the nipples are drawn out without any effusion of blood. Delivery, which entirely consists of this separation, should not, therefore, produce any blood. Is it not then more accordant with reason to suppose, that it is the action of the

the blood which causes delivery, and that it is this menstrual blood which forces the vessels as soon as the matrix is emptied, and which begins to flow immediately after delivery as it did before conception?

It is known, that in the first months of pregnancy that which contains the seed of generation is not adherent to the matrix. By the experiments of De Graaf it has been seen, that by blowing on the little ball we can make it move. The adhesion to the matrix is never very strong, and at first the placenta with difficulty adheres to the internal membrane of the viscera, and those parts are only contiguous, or joined by a mucilaginous matter, which has scarcely any adhesion. Why then does it occur, that in miscarriages of the first and second month this ball never escapes without a great effusion of blood? It is certainly not caused by the passage of the ball quitting the matrix, since it does not adhere to it; but it is, on the contrary, by the action of this blood that the ball is driven out. Must we not then conclude this blood to be menstrual, which by forcing the canals, through which it had been accustomed to pass before impregnation,

 destroys

destroys the product of conception by retaking its common road?

It appears, therefore, that the periodical revolution of the menstrual blood has great influence on delivery, and that it is the cause why the times of delivery in women vary so much more than in every other female who is not subject to the periodical evacuation, and which always bring forth at the same times. It also appears that this revolution, occasioned by the action of the menstrual blood, is not the sole cause of birth, but that the action of the fœtus itself contributes towards it, since there are instances of a child escaping from the womb after the death of the mother, which necessarily supposes an action proper and particular in itself.

The space of time which cows, sheep, and other animals go with young is always the same, and their deliveries are not attended with an hæmorrhage. May we not then conclude, that the blood voided by women after delivery is the menstrual blood, and that the human fœtus being born at such different terms, can only be by the actions of this blood on the matrix during every periodical revolution? It is

is natural to imagine, that if the females of viviparous animals had menses like women, their deliveries would be followed with an effusion of blood, and happen at different terms. The fœtuses of animals come into the world cloathed with their membranes (and it seldom happens that the membranes are broken), and the waters flow before the delivery; whereas it is very rare a child is brought forth with its membranes entire. This seems to prove that the human fœtus makes more efforts than other animals to quit its prison; or that the matrix of a woman does not so naturally incline to the passage of the child, for it is the fœtus which tears its membranes, by the efforts it makes against the resistance it meets with at the orifice of the viscera.

RECAPITULATION.

ALL animals procure nutriment from vegetables, or other animals which feed upon vegetables; there is, therefore, one common matter to both, which serves for the nutrition

and expansion of every thing which lives or vegetates. This matter cannot perform them but by assimilating itself to each part of the animal or vegetable, and by intimately penetrating the texture and form of these parts, which I have called the *internal mould*. When this nutritive matter is more abundant than is necessary to nourish and expand the animal or vegetable, it is sent back from every part of the body, and deposited in one or more reservoirs, in the form of a liquor; this liquor contains all the molecules analogous to all parts of the body; and consequently all that is necessary for the reproduction of a young being, perfectly resembling the first. Commonly this nutritive matter does not become superabundant, in most kinds of animals, till they have acquired the greatest part of their growth; and it is for this reason that animals are not in a state of engendering before that time.

When this nutritive and productive matter, which is universally spread abroad, has passed through the internal mould of an animal or vegetable, and has found a proper matrix, it produces an animal or vegetable, of the same kind; but when it does not meet with a proper matrix, it produces organized beings different from

from animals and vegetables, as the moving and vegetating bodies seen in the seminal liquor of animals, in the infusion of the germ of plants, &c.

This productive matter is composed of organic particles, always active, the motion and action of which are fixed by the inanimate parts of matter in general, and particularly by oily and saline bodies, but as soon as they are disengaged from this foreign matter, they retake their action, and produce different kinds of vegetations and other animated beings.

By the microscope, the effects of this productive matter may be perceived in the seminal liquors of animals of both sexes. The seed of the female viviparous animals is filtered through the glandular bodies which grow upon their testicles, and these glandular bodies contain a large quantity of seminal fluid in their internal cavities. Oviparous females have, as well as the viviparous, a seminal liquor, which is still more active than the viviparous. The seed of the female is in general like that of the male, when they are both in a natural state: they decompose after the same manner, contain similar organic bodies, and they alike offer the same phenomena.

All

All animal or vegetable substances include a great quantity of this organic and productive matter. To perceive it, we need only separate the inanimate parts in which the active particles of this matter are engaged. And this is done by infusing animal or vegetable substances in water. The salts will dissolve, the oils separate, and the organic particles will be seen by their putting themselves in motion. They are in greater abundance in the seminal liquors than in any other parts, or rather, they are less entangled by the inanimate parts. In the beginning of this infusion, when the flesh is but slightly dissolved, the organic matter is seen under the form of moving bodies, which are almost as large as those of the seminal liquors: but, in proportion as the decomposition augments, these organnic particles diminish in size and increase in motion; and when the flesh is entirely decomposed, or corrupted, these same particles are exceedingly minute, and their motion exceedingly rapid. It is then that their matter may become a poison, like that of the tooth of a viper, wherein Mr. Mead perceived an infinite number of small pointed bodies, which he took for salts, although they are only these same organic particles in a

state

state of great activity. The pus which issues from wounds abounds with little insects, and it may take such a degree of corruption as to become one of the most subtle poisons; for every time this active matter is exalted to a certain point, which may be known by the rapidity and minuteness of the moving bodies it contains, it will become a species of poison. It is the same with the poison of vegetables. The same matter which serves to feed us when in its natural state, will destroy us when corrupted. Spurred barley, for instance, throws the limbs of men and animals into a gangrene who feed on it. It is also evident by comparing the matter which adheres to our teeth, which is the residue of our food, with that from the teeth of a viper or mad dog, which is only the same matter too much exalted, and corrupted to the last degree.

When this organic and productive matter is found collected in a great quantity in some part of an animal, where it is obliged to remain, it forms living beings which have been ever regarded as animals; the tænia, ascarides, all the worms found in the veins, liver, in wounds, in corrupted flesh, and pus, have no other origin; the eels in paste, vinegar, and all the pretended

microscopical animals are only different forms which this active matter takes of itself, according to circumstances, and which invariably tends to organization.

In all animal and vegetable substances, decomposed by infusion, this productive matter manifests itself immediately under the form of vegetation. Filaments are seen to form, which grow and extend like plants. Afterwards these extremities and knots swell and burst, to give passage to a multitude of bodies in motion, which appear to be animals; so that it seems as if all nature began by a motion of vegetation. It is seen by microscopical objects, and likewise by the expansion or unfolding of the animal embryo; for the fœtus at first has only a species of vegetable motion.

Sound food does not furnish any of these moving molecules for a considerable time. Several days infusion in water is required for fresh meat, grain, kernels, &c. before they offer to our sight any moving bodies; but the more matters are corrupted, decomposed, or exalted, the more suddenly these moving bodies manifest themselves; they are all free from other matters in seminal liquors; but a few hours

infusion

infusion is required to see them in pus, spurred barley, honey, drugs, &c.

There exists therefore, an organic matter, universally diffused in all animal and vegetable substances, which alike serves for their nutrition, their growth, and their reproduction. Nutrition is performed by the intimate penetration of this matter in all parts of the animal or vegetable body. Expansion or growth is only a kind of more extended nutrition, which is made and performed as long as the parts have sufficient ductility to swell and extend; and reproduction is made by the same matter when it superabounds in the body of the animal or vegetable; each part of the body sends back, to the appropriate reservoirs, the organic particles which exceed what are sufficient for their nourishment. These particles are absolutely analogous to each part from which they are sent back, because they were destined to nourish those parts from hence, when all the particles sent back from, collect together, they must form a body similar to the first, since each particle is like that part from which it was detached; thus it is that reproduction is effected in all kinds of trees, plants, polypuses, pucerons, &c. where one individual can produce its like; and it is

also the first mode which Nature uses for the reproduction of animals which have need of the communication of different sexes; for the seminal liquors of both sexes contain all the necessary molecules for reproduction; but something more is required for its effectual completion, which is the mixture of these two liquors in some places suitable to the expansion of the fœtus which must result therefrom, which place is the matrix of the female.

There are, therefore, no pre-existing germs, no germs contained one in the other, *ad infinitum;* but there is an organic matter perpetually active, and always ready to form, assimilate, and produce beings similar to those which receive it. Animals and vegetables, therefore, can never be extinct; so long as there subsist individuals the species will ever be new; they are the same at present as they were three thousand years ago, and will perpetually exist, by the powers they are endowed with, unless annihilated by the will of the Almighty Creator.

HISTORY

HISTORY OF MAN.

CHAPTER I.

OF THE NATURE OF MAN.

THOUGH so much interested in acquiring a thorough knowledge of ourselves, yet I do not know if man is not less acquainted with the human, than with any other existence. Provided by nature with organs, calculated solely for our preservation, we only employ them to receive foreign impressions. Intent on multiplying the functions of our senses, and on enlarging the external bounds of our

 being,

being, we rarely make use of that internal sense which reduces us to our true dimensions, and abstracts us from every other part of the creation. It is, however, by a cultivation of this sense alone that we can form a proper judgment of ourselves. But how shall we give it its full activity and extent? How shall the soul, in which it resides, be disengaged from all the illusions of the mind? We have lost the habit of employing this sense; it has remained inactive amidst the tumult of our corporeal sensations, and dried up by the heat of our passions; the heart, the mind, the senses, have all co-operated against it.

Unalterable in its substance, and invulnerable by its essence, it still, however, continues the same. Its splendor has been overcast, but its power has not been diminished: it may be less luminous, but its guidance is not the less certain. Let us then collect those rays, of which we are not yet deprived, and its obscurity will decrease; and though the road may not in every part be equally filled with light, we yet shall have a torch that will prevent us from going astray.

The first and most difficult step which leads to the knowledge of ourselves, is a distinct

tinct conception of the two substances that constitute our being. To say simply, that the one is unextended, immaterial, and immortal, and that the other is extended, material, and mortal, is only to deny to the one, what we affirm the other possesses. What knowledge is to be acquired from this mode of negation? Such negative expressions can exhibit no positive ideas: but to say that we are certain of the existence of the former, and that of the latter is less evident; that the substance of the one is simple, indivisible, and has no form, since it only manifests itself by a single modification, which is thought; that the other is a less substance than a subject, capable of receiving different forms, which bear a relation to our senses, but are all as uncertain and variable as the organs themselves; that is to say something; it is to ascribe to each such distinct and positive properties as may lead us to an elemental knowledge of both, and to a comparison between them.

From the smallest reflection on the origin of our knowledge, it is easy to perceive that it is by comparison alone we acquire it. What is absolutely incomparable, is utterly incomprehensible; of this God is the only example; he exceeds

exceeds all comprehension, because he is above all comparison. But whatever is capable of being compared, contemplated, and considered relatively, in different lights, may always come within the sphere of our understanding. The more subjects of comparison we have for examining any object, the more methods there are for obtaining a knowledge of it, and with greater facility.

The existence of the soul is fully demonstrated. To be and to think are with us identically the same. This truth is more than intuitive; it is independent of our senses, of our imagination, of our memory, and of all our other relative faculties. The existence of our bodies, and of external objects, is however held in uncertainty by every unprejudiced reasoner; for what is that extension of length, breadth, and thickness, which we call our body, and which seems to be so much our own, but as it relates to our senses? What are even the material organs of those senses, but so many conformities with the objects that affect them? And with regard to our internal sense, has it any thing similar or in common with these external organs? Have the sensations excited by light or sound any resemblance to that

tenuous

tenuous matter, which seems to diffuse light, or to that tremulous undulation, which sound produces in the air? The effects are certainly produced by the necessary conformity there is between the eyes and ears, and those matters which act upon them. Is not that a sufficient proof, that the nature of the soul is different from that of matter?

It is then a certain truth, that the internal sensation is altogether different from its cause; as also, if external objects exist, they are in themselves very different from what we conceive them. As sensation therefore bears no resemblance to the thing by which it is excited; does it not follow, that the causes of our sensations, necessarily differ from our ideas of them? The extension which we perceive by our eyes, the impenetrability, of which we receive an idea by the touch in all those qualities, whose various combinations constitute matter, are of a doubtful existence; since our internal sensations of extension, impenetrability, &c. are neither extended nor impenetrable, and have not even the smallest affinity with those qualities.

The mind being often affected with sensations, during sleep, very different from those

which it has experienced by the presence of the same objects, does it not lead to a belief, that the presence of objects is not necessary to the existence of our sensations; and that, of consequence, our mind and body may exist independent of those objects? During sleep, and after death, for example, our body has the same existence as before; yet the mind no longer perceives this existence, and the body with regard to us, has ceased to be. The question is therefore, whether a thing which can exist, and afterwards be no more, and which affects us in a manner altogether different from what it is, or what it has been, may yet be a reality of indubitable existence.

That something exists without us, we may believe, though not with a positive assurance; whereas of the real existence of every thing within us, we have a certainty. That of our soul, therefore, is incontestable, and that of our body seems doubtful; because the mind has one mode of perception when we are awake, and another when we are asleep; after death, it will perceive by a method still more different, and the objects of its sensations, or matter in general, may then cease to exist with respect to

it,

it, as well as our bodies with which we have no further connection.

But let us admit this existence of matter; and that it even exists as it appears to our senses, yet by comparing the mind with any material object, we shall find differences so great, and qualities so opposite that every doubt will vanish of the latter being of a nature totally different, and infinitely superior.

The mind has but one form, which is simple, general, and uniform. Thought is this form; has nothing in it of division, extension, impenetrability, nor any other quality of matter; of consequence, therefore, our mind, the subject of this form, is indivisible, and immaterial. Our bodies on the contrary, and all other objects have many forms, each of which is compounded, divisible, variable, and perishable; and has a relation to the different organs, through which we perceive them. Our bodies, and matter in general, therefore, have neither permanent, real, nor general properties, by which we can attain a certain knowledge of them. A blind man has no idea of those objects, which sight represents to us; a leper, whose skin has lost the sense of feeling, is denied all the ideas which arise from the touch; and a deaf

man has no knowledge of sounds. Let these three modes of sensation be successively destroyed, yet the mind will exist, its external functions will subsist, and thought will still manifest it within the man so deprived. But divest matter of all its qualities; strip it of colour, of solidity, and of every other property which has any relation to our senses, and the consequence will be its annihilation. Our mind, then, is unperishable, but matter may, and will perish.

It is the same with all the other faculties of our soul when compared with the most essential properties of matter. As the mind wills and commands, so the body obeys in every thing within its power. The mind forms, at pleasure, an intimate union with any object; neither distance, magnitude, nor figure, can obstruct this union, when the mind wills it, it is effected in an instant. The body can form no union; whatever touches it too closely injures it; it requires a long time in order to approach another body; it every where meets with resistance, and obstacles, and from the smallest shock its motion ceases. Is will then nothing more than a corporeal movement; and is contemplation but a simple contact? How could

this contact take place upon a remote object or abstracted subjects? How could this movement be accomplished in an indivisible instant? Is it possible to have a conception of motion without having a conception of space and time? Will, therefore, if it be a motion, is not a material one; and if the union of the mind with its object be a contact, it is effected at a distance: and is not this contact a penetration? qualities which are absolutely opposite to those of matter, and which of consequence can only belong to the immaterial being.

But I fear I have already dwelt too long on a subject which, by many, may be considered as foreign to our purpose; and it might be asked, "Ought Metaphysical Considerations on the Soul to find a place in a System of Natural History?" Were I conscious of abilities equal to the discussion of a topic so exalted, this reflection, I must own, would have little weight with me; and I have contracted my remarks only because I was afraid I should not be able to comprehend a subject so enlarged and so important in its full extent. Why retrench from the Natural History of Man the history of his noblest part? Why thus preposterously debase him, by considering

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him merely as an animal, while he is of a nature so different, and so superior, to that of the brutes, that those must be immersed in ignorance like the brutes themselves who ever thought of confounding them.

Man, as to the material part of his existence, certainly bears a resemblance to other animals, and in comprehending the circle of natural beings there is a necessity for placing him in the class of animals. Nature, however, has neither classes nor species; it contains only individuals. These species and classes are nothing but ideas which we have ourselves formed and established, and though we place man in one of such classes we do not change his being; we do not derogate from his dignity; we do not alter his condition. In a word, we only place him at the head of those who bear a similitude to him in the material part of his being.

In comparing man with the animal we find in both an organized body, senses, flesh, blood, motion, and a multitude of other resemblances. But these resemblances are all external, and not sufficient to justify a decision, that the human and the animal natures are similar. In order to form a proper judgment of the nature of

of each we ought to have as distinct a knowledge of the internal qualities of an animal as we have of our own. As the knowledge of what passes within animals is impossible to be attained, and as we know not of what order and kind its sensations may be, in relation to those of man, we can only judge from a comparison of the effects which result from the natural operations of both.

Let us, then, take a view of these effects; and, while we admit of all the particular resemblances, limit our investigation to the most general distinctions. It will be allowed, that the most stupid man is able to manage the most acute animal; he governs it, and renders it subservient to his purposes; and this, not so much on account of his strength or skill as by the superiority of his nature, and from his being possessed of reason, which enables him to form a rational system of action and method, by which he compels the animals to obey him. The strongest and most acute animals do not give law to the inferior, nor hold them in servitude. The stronger, it is true, devour the weaker, but this action implies no more than an urgent necessity, or a rage of appetite; qualities very different from that which produces a series

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of actions, all tending to the same end. Did animals enjoy this faculty, should we not see some of them assume dominion over others, and oblige them to furnish their food, to watch over them, and to attend them when sick or wounded? Now, throughout the creation of animals, there is no vestige of such subordination, no appearance that one of them knows, or is sensible of, the superiority of his own nature over that of others. It follows, then, that they must all be considered as of one nature, and that the nature of man is not only highly superior to that of the brute, but also entirely different from it.

Man, by outward signs, indicates what passes within him; he communicates his sentiments by speech, which is a sign common to the whole human species. The savage and the civilized man have the same powers of utterance; both speak naturally, and so as to be understood. No other animal is endowed with this expression of thought; nor is that defect owing, as some have imagined, to the want of proper organs. Anatomists have found the tongue of an ape to be as perfect as that of a man. The ape, therefore, if he had thought, would have speech, and if its thoughts had

aught analogous to ours, this speech would have an analogy to ours also. Supposing its thoughts were peculiar to its species, it still would hold discourse with those of its kind, a circumstance of which we should have heard had it been endowed with the powers of speech. So far then is the ape from having any thought like ours, that it has not even any order of thoughts of its own. As they express nothing by combined and settled signs, they of consequence are void of thought, or at most have it in a very small degree.

That it is from no organical defect animals are denied the gift of speech is plain, as several species of them may be taught to pronounce words, and even repeat sentences of some length. Perhaps many others might be found capable of articulating particular sounds*; but to make them conceive the ideas which such sounds denote is an impracticable task. They seem to repeat and articulate merely as an echo, or an artificial machine. It is not in the mechanical powers, or the material organs, but in the intellectual faculties, that they are deficient.

* Leibnitz mentions a dog which had been taught to pronounce several German and French words.

As all language supposes a chain of thought, it is on that account that brute animals have no speech, for even allowing something in them which resembles our first apprehensions, our most gross and mechanical sensations, they still will be found incapable of forming that association of ideas which can alone produce reflection; and in this consists the essence of thought. To this inability of connecting and separating ideas it is that they are destitute of thought and speech, as also that they neither can invent nor improve any thing. Were they endowed with the power of reflection, even in the most subordinate degree, they would be capable of making some kind of proficiency, and acquire more industry; the modern beaver would build with more art and solidity than the ancient; and the bee would daily be adding new improvements to its cell; for if we suppose this cell as perfect already as it can be, we ascribe to the insect an intelligence superior to our own; by which it could discern at once the last degree of perfection to which its work might be carried, while we ourselves are for ever in the dark as to this degree, and stand in need of much reflection, time, and practice, in order to perfect even one of our most trivial arts.

Whence

Whence can arise the uniformity that is in all the works of animals? Why does each species invariably perform the same actions in the same manner? And why does not one individual perform them better or worse than another? Can there be a stronger proof that their operations are merely the effects of mechanism and materiality? If they possessed the smallest spark of that light which is inherent in mankind, their works would display variety at least, if not perfection, and one individual would, in its performance, make some little difference from what another had done. But this is far from being the case. One plan of action is common to the whole species, and whoever would attribute a mind or soul to animals, must of necessity allow but one to each species, of which each individual would be an equal partaker, and as thereby it would be divisible, it would consequently be material, and of a nature widely different from ours.

Why, on the other hand, are the productions and performances of men so various and so diversified? Why is a servile imitation more troublesome to us than an original design? It is because our souls are our own, and independent of any other, and because we have no-

thing in common with our species but the matter which forms our body, and in which our resemblance to brute animals is confined.

Were internal sensations dependent on corporeal organs, should we not see as remarkable difference in the works of animals of the same species as in those of men? Would not those which were the most happily organized, build their nests and contrive their cells in a manner more solid, elegant, and commodious? And if any individual possessed a superior genius, would it not take an opportunity to manifest that superiority in its actions? But nothing of this kind has ever happened, and therefore the corporeal organs, however perfect or imperfect, have no influence on the nature of the internal sensations. Hence we may conclude, that animals have no sensations of this kind; that such sensations have no connection with matter, no dependence in their nature on the texture of corporeal organs, and that of consequence there must be a substance in man different from matter, which is the subject and the cause that produces and receives those sensations.

But these proofs of the immateriality of the human mind may be carried still farther. In

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all the works of nature there are imperceptible gradations maintained. This truth, which in no other instance admits of exception, is here expressly contradicted. Between the faculties of man and those of the most perfect animal the distance is infinite; an evident proof that man is of a different nature from the brute species, and that of himself he forms a distinct class, between which and that of animals there is an immense chasm. If man belonged to the class of animals, there would be a certain number of beings in nature less perfect than man, and more perfect than beast, in order to complete the gradation from a man to the monkey. But this is not the case; the transition is immediate from the thinking being to the material being; from intellectual faculties to mechanical powers; from order and design to blind motion; from reflection and choice to sensual appetite.

Enough has been here advanced to demonstrate the excellence of our nature, and of the immense distance which the bounty of the Creator has placed between man and the brute. The former is a rational being, the latter a being devoid of reason. And as there is no medium between the positive and the negative,

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between the rational and irrational being, it is evident that man is of a nature entirely different from that of the animal; that all the resemblance he bears to it is merely external; and that to judge of him by this resemblance, is wilfully to shut our eyes against that light, by which we ought to distinguish truth from falsehood.

Having thus considered man as to his internal properties, and proved the immateriality of his soul; we shall now proceed to examine his external part, and give the history of his body. We have already traced him from his formation to his birth, and after taking a view of the different ages of his life, we shall conduct him to that period when he must be separated from his body, and then resign him to the common mass of matter to which he belongs.

CHAPTER III.

OF INFANCY.

NOTHING can give us a more striking idea of imbecility, than the condition in which an infant appears on its first entrance into the world. Incapable of making use of its organs,

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or senses, the infant is in want of every assistance. It is an image of pain and misery; it is more helpless than the young of any other animal; it seems as if every moment would finish its doubtful existence; it can neither move nor support itself; hardly has it strength enough to exist or announce, by its cries, the sufferings it experiences; as if nature chose to apprise it, that it was born to suffer, and that it has obtained a place among the human species to partake of its infirmities and sorrows.

Let us not disdain to consider that state through which we have all passed; let us view human kind in the cradle; let us enquire by what degrees this delicate machine, this new-born and hardly existing body, acquires motion, consistency, and strength.

The infant at its birth comes from one element into another. On emerging from its watery residence in the womb, it becomes exposed to the air, and instantly experiences the impressions of that active fluid. The air acts upon the olfactory nerves and upon the organs of respiration, and thereby produces a shock, a kind of sneezing which expands the chest, and allows the air a passage into the lungs; the vesicles of which it dilates, and the air remaining

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for some time becomes warm and rarified to a certain degree; after which this spring of the fibres thus dilated re-acts upon this light fluid, and expels it from the lungs. Instead of undertaking to explain the causes of the alternate motion of respiration, we shall confine ourselves to an elucidation of its effects. This function is essential to the existence of man and of several species of animals. It is by respiration that life is preserved: and when it is once begun, it never ceases till death. Yet there is reason to believe that the foramen ovale is not closed immediately after the birth; and of consequence a part of the blood may continue to pass through that aperture. All the blood cannot, therefore, at first have a communication with the lungs; and it is probable a new-born child might sustain a privation of air for a considerable time without losing its existence. Or at least the possibility of this, I once seemingly confirmed by an experiment upon some young dogs. I put a pregnant bitch, of the large greyhound species, just as she was about to litter, into a tub filled with warm water, where after fastening her in such a manner that the lower parts were covered with some water, she brought forth three puppies, which were accordingly

received into a liquid as warm as they had left. After washing them in this water, I removed the puppies, without giving them time to breathe, into a smaller tub filled with warm milk; I chose milk in order that they might receive nourishment if they required it. In this milk they were kept immersed above half an hour; and when taken out they were all found alive. They began to breathe, and to discharge some moisture by the mouth. Having allowed them to respire for half an hour, I again put them into warm milk, and left them a second half-hour; at the expiration of which two of them were taken out vigorous and seemingly no wise incommoded, but the third appeared rather in a languishing state; this I caused to be carried to the mother, which by this time had produced, in the natural way, six other puppies; and though it had been brought forth in water and had lived in milk one half hour before, and another after it had breathed, it yet received so little injury from the experiment, that it presently recovered and was as strong and lively as the rest of the litter. After allowing the other two about an hour to breathe, I put them once more into the warm milk, in which they remained another half hour. Whe-

ther they swallowed any of this liquor or not is uncertain: but on being taken out they appeared nearly as vigorous as ever. After being carried to the mother, however, one died the same day; but whether by any accident, or by what it had suffered while immersed in the liquid, and deprived of air, I could not determine. The other lived, as well as the first, and both throve equally with those which had not gone through the same trials. This experiment I never carried farther: but I saw enough to convince me that respiration is less necessary to a new-born, than to a grown animal; and that it might be possible, with proper precautions, to keep the foramen ovale from being closed, and thus produce excellent divers, and different kinds of amphibious animals, which might live equally in air or in water.

The air, on its first admission into the lungs, generally meets with some obstacle, occasioned by a liquid collected in the wind-pipe. This obstacle is more or less great, in proportion as the liquid is more or less viscous. At its birth, however, the infant raises it head, which before reclined on its breast, and by this movement the canal of the wind-pipe is lengthened, the air obtains a place, and forces the liquid into

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the lungs: and by dilating the bronchia, it distributes over their coats the mucous substance which opposes its passage. The superfluity of this moisture is presently dried up by the renewal of the air; or, if the infant is incommoded by it, it coughs, and at length relieves itself by expectoration, which, as it has not yet the strength to spit, is seen to flow from the mouth.

As we remember nothing of what happened to us at this period, it is impossible to determine what feelings the impression of air produces in a new-born infant. Its cries, however, the instant it first draws breath, are pretty certain signs of the pain it feels from the action of the air. Till the moment of its birth, the infant is accustomed to the mild warmth of a tranquil liquid: and we may suppose, that the action of a fluid, whose temperature is unequal, gives too violent a shock to the delicate fibres of its body. By warmth and by cold it seems to be equally affected; in every situation it complains, and pain appears to be its first, its only sensation.

For some days after they are brought into the world, most animals have their eye-lids closed. Infants open them the moment of their birth,

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but they are fixed and dull; they want that lustre which they afterwards acquire; and when they move, it is rather an accidental roll than an act of vision. The pupil of the eye is seen to dilate, or contract, in proportion to the quantity of light it receives, yet is incapable of distinguishing objects, because the organs of vision are still imperfect; the tunica cornea, or horny tunicle is wrinkled, and perhaps the retina is also too soft to receive the images of external objects, and admit the sense of seeing.

The same remark is equally applicable to the other senses; they have not acquired that consistency which is necessary to their operations; and even when they have, a long time must elapse before the sensations of the infant can be just and complete. The senses are so many instruments which we must learn to employ. Of these sight, which seems to be the noblest and the most admirable, is also the most uncertain and delusive; and were its effects not every moment corrected by the testimony of touching we should constantly be misled and draw false conclusions. This sense of touching is the measure and criterion of all the others; it alone is essential to the animal's existence; and is

alone

alone diffused universally over its body. Yet, even this sense, in an infant just born, is imperfect; by its cries, indeed, it gives indication of pain; but it has no expression to denote pleasure. It is forty days before it begins to smile; about the same time also it begins to weep; its former expressions of pain being unaccompanied with tears. On the countenance of a new born infant there appears no vestige of the passions, the features of the face not having acquired that consistence and form which are necessary for expressing the sentiments of the soul. All the other parts of its body are alike feeble and delicate; its motions are unsteady and uncertain; it is unable to stand upright; its legs and thighs are still bent, from the habit it contracted in the womb; it has not strength enough to stretch forth its arms or to grasp any thing with its hands; and, if abandoned, it would remain on its back, without being able to turn itself.

From all which it appears, that the pain felt by infants soon after their birth, and which they express by crying, is a sensation merely corporeal, similar to that of other animals, who also cry the minute they are brought forth; as also, that the mental sensations do not begin to

manifest

manifest themselves till forty days have elapsed; smiling and weeping being produced by two internal sensations, which both depend on the action of the mind. The former is the effect of an agreeable emotion, which can only arise from the sight, or resemblance of an object known, beloved, and desired; the latter is that of a disagreeable impression, compounded of sympathy, and anxious concern for ourselves; both imply a certain degree of knowledge, as well as an ability to compare, and to reflect. Smiles and tears, therefore, are signs peculiar to the human species, for expressing mental pleasure or pain; while cries, and the other signs of bodily pain and pleasure, are common to man, and to the greatest part of the animal creation.

But let us return to the material organs and affections of the body. The size of an infant born at the full time, is usually about twenty-one inches; this is not without exception, some falling short of and others exceeding this measurement. In children of twenty-one inches, the breast, measured by the length of the sternum, is nearly three inches; and in those of fourteen, only two inches. At nine months, the fœtus generally weighs from twelve to fourteen

teen pounds. The head is large in proportion to the rest of the body; but this disproportion gradually wears off as the size of the child encreases. Its skin is very soft, and from its transparency, by which the blood beneath appears, it is also of a reddish cast. It is even pretended, that those children whose skins are the most red when born, will afterwards be the fairest, and the most beautiful.

The form of the body and the members of a new born infant, are by no means perfect: all the parts are too round, and even when the child is in good health, they seem swelled. At the end of three days, there generally appears a kind of jaundice; and at this time there is generally milk in the breasts of the infants, which is squeezed out with the fingers. The superfluous juices, and the swelling of the different parts diminish by degrees, as the child increases in growth.

In some children just born, the brain-pan may be observed to palpitate; and in all, the action of the sinuses, or arteries of the brain, may be felt at this place. Over this aperture is formed a kind of scurf, which is sometimes very thick, and must be rubbed with brushes in proportion as it begins to dry. This matter seems to have some analogy with that of the

horns

horns of some animals, which also derive their origin from an aperture of the skull, and from the substance of the brain. We shall hereafter take an opportunity to shew, that the extremities of the nerves become solid by being exposed to the air, and that it is this nervous substance produces claws, nails, horns, &c.

The fluid contained in the amnios leaves a viscous, whitish matter upon the infant, which is sometimes so adhesive, that it must be diluted with some mild liquid before it can be removed. In this country we never wash the infant but in warm water; yet there are whole nations, who inhabit climates much more severe than ours, that plunge their children into cold water the minute they are born, without their suffering the least injury. The Laplanders are even said to leave their infants in snow, till by the cold their respiration is nearly stopped, and then plunge them into a bath of warm water. They are treated thus roughly thrice every day during the first year, and afterwards as often every week, do they undergo an immersion in cold water. The people of the North are persuaded that the practice of cold bathing renders men more healthy and robust; and it is for this reason they enure their progeny to it from their birth.

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The truth is, we are ignorant with the extent of what our body is capable of suffering, acquiring, or losing by the power of habit. The Indians in the isthmus of America, for example, receive no injury from plunging into cold water when in a sweat; and as the most speedy remedy for intoxication, the women throw their husbands into the river when they are drunk; the minute after delivery, mothers scruple not to bathe in cold water with their infants, and yet dangerous as we should consider this practice, these women are rarely known to die in child-bearing.

A few minutes after birth the infant discharges urine, and this generally when it feels the heat of the fire: and sometimes also the meconium or excrement which have been collected in the intestines during its residence in the matrix. This last evacuation is not always performed so soon, but if it does not happen in the course of the first day, the child is often affected with a pain in the bowels; in which case methods are taken to facilitate the discharge. The meconium is black, and when the infant is effectually eased of it, the subsequent stools are of a whitish cast. This change generally happens on the second or third day, and then the excrement becomes more fœtid than the

meconium; a proof that the bile and other bitter humours of the body begin to intermix with it. This fact tends to support our former remark, that the fœtus did not receive any food by its mouth, but received all its nourishment by absorption.

The infant is allowed time to throw off the slime and meconium, which are in its bowels and intestines, before it is allowed to suck. As these substances might sour the milk, and produce bad effects, it is first made to swallow a little wine and sugar, in order to fortify the stomach, and to procure such evacuations as may be necessary to prepare it for receiving and digesting its food; nor ought it to receive the breast till 10 or 12 hours after the birth.

Hardly has the infant left the womb of its mother, and enjoyed the liberty of extending its limbs, when it is again put into a more cruel confinement. The head of the helpless infant is fixed to one position; its arms and legs put in strict bondage, and it is laced with bandages so strait as not to be able to move a single joint. Well is it when the compression is not so great as to obstruct the respiration, or that the midwife has taken the precaution to lay it upon its side, that the natural moisture may emit of itself from the mouth, since it is denied

denied the power of turning its head in order to facilitate this emission. Do not then those nations act more wisely than we who cover or clothe their children without shackling them in swathing-bands? the Siamese, the Japanese, the Indians, the Negroes, the Savages of Canada, of Virginia, or Brazil, and almost all the inhabitants of South America, lay their infants naked upon a suspended bed of cotton or put them into their cradles lined with fur. Those practices are certainly liable to less inconveniences than ours. In swaddling a child, it is impossible but the restraint must give it uneasiness; and the efforts it makes to disentangle itself have a greater tendency to injure the form of the body, than any position it might assume was it left at full liberty. Swathing-bands may be compared to stays, which young girls are made to wear in order to preserve their shapes, but which nevertheless occasion more diseases and deformities than they are supposed to prevent.

If the efforts which children make for liberty, when confined in the swaddling-cloaths, are hurtful, the inaction in which they are held by it, is perhaps still more so. Want of exercise naturally retards the growth of their limbs, and diminishes the strength of their bodies; and

and of consequence such children as enjoy the liberty of moving at pleasure, must be the most vigorous. It was for this reason that the ancient Peruvians gave their infants the full freedom of their arms in a swathing-bag; afterwards, as their children grew, they put them up to the middle in a hole dug in the earth, and lined with linen; by this method they had their arms free, and could move their heads and bend their bodies, without falling or hurting themselves. So soon as they were able to step, they were presented with the breast, at a little distance, as an incentive for them to walk. The children of Negroes are often exposed to much greater fatigues, in order to come at the nipple, they cling round one of their mother's haunches with their legs, and support themselves without any assistance from her; seizing the breast they continue to suck in perfect safety, notwithstanding she is all the while in motion, or at work. These children begin to walk, or rather creep on their knees and hands, in the second month; and this exercise qualifies them for running afterwards in this manner, almost as nimble as they do upon their feet.

END OF THE THIRD VOLUME.

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